MADRAS FISHERIES DEPARTMENT

Bulletin No. XV

FISHERY REPORTS

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EDITED BY

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Report No. 1 of 1922.

ADMINISTRATION REPORT OF THE DEPARTMENT OF FISHERIES FOR THE YEAR ENDING 30TH JUNE 1921

BY

J. HORNELL, ESQ., F.L.S., F.R.A.I.,
DIRECTOR OF FISHERIES.

ADMINISTRATION.

1. *Personnel.*—Mr. A. Y. G. Campbell, C.I.E., continued to act as Director till 15th November 1920, on which date I returned from leave and resumed charge of the Directorate. No change in the superior staff took place during the year. Rao Bahadur V. Govindan, as Assistant Director (Coast), continued in charge of the socio-economic section, together with the supervision of the Tanur Experimental Station, the fish-curing yards and the inshore experiments at Madras. Mr. H. L. Prager was responsible for the Experimental Cannery at Chaliyam, whilst Mr. J. A. Fernandez controlled the chank and beche-de-mer fisheries, in the absence on leave of Lieut. J. H. Allan, O.B.E., who returned only on June 7, 1921. Mr. R. H. Whitehouse carried on the duties of Marine Biologist, and Mr. B. Sundara Raj, Assistant Director (Inland), those pertaining to Inland Pisciculture. Mr. Karunakara Menon continued as Personal Assistant to the Director.

2. *Headquarters office and staff.*—As in 1919 I have again to deplore the inadequacy of the accommodation provided for my establishment and that of the Assistant Director (Inland). This consists of a small wing attached to the Director of Industries' offices. My own office is in a converted dressing room, so small and hot that it is difficult to work there in the heat of the day. The clerks are in worse condition, as they are crowded into two hot and ill-ventilated rooms. The Assistant Director's (Inland) staff is housed under equally unsuitable and unhygienic conditions. Unless better quarters are provided, the efficiency of work, now at a low level, is likely to deteriorate further. The need for additional staff is also sorely felt, and results in the utilization of the services, as clerks, of men whose duties are not of this description. Thus the Personal Assistant, specially appointed to relieve me of certain duties, in order that I might have time for greater general supervision and for research, is occupied to such an extent with accounts work that I do not get as much relief from his help as I should. Similarly my camp clerk can seldom accompany me on tour, and the Assistant

Director (Inland), to make up for the lack of adequate clerical staff, has frequently to utilize the services of his Assistant Inspectors. The work of the department has increased very greatly during the past two years but the additional staff asked for long ago has not yet been sanctioned. The work of the Assistant Director (Coast) similarly suffers, and like my own is always more or less in arrears in consequence.

General.

3. *Expansion of work.*—This has continued in certain directions, such as the more vigorous preparation of scientific and technical reports for publication, increase in the number of schools and fish-curing yards under the charge of the department, and in a large extension of the operations of the piscicultural section. One hundred and thirty-five tanks were taken over under the authority of G.O. No. 217, Revenue (Special), dated 3rd February 1920, from the District Boards of Chingleput and Nellore. To meet the needs of this section for subordinates trained on the technical side, I arranged for the utilization of the Ennore bungalow as a modest but efficient training institute for this purpose; the results have been gratifying and it may be possible to develop this temporary arrangement into a permanent and economical training scheme that will obviate the need for a costly Fishery College as proposed in more prosperous times.

4. *Finance.*—Expenditure on non-industrial sections of the work, especially education, socio-economics, supervision and research, continues to increase; as a consequence the excellent financial result in the piscicultural section and the fairly good one from the chank fishery are masked. The total revenue from all sources amounted to Rs. 2,29,420, the expenditure to Rs. 2,93,027, a loss of Rupees 63,607 as compared with Rs. 19,087 in 1919–20. The increase in the deficit by Rs. 44,520 is due in the main to increases in supervision and research (Rs. 5,400 to the Marine Biologist alone), in temporary additions to the pay of the establishment (Rs. 14,000), in travelling allowances due chiefly to the increased rates given (Rupees 5,000), and Rs. 3,000 upon education and socio-economic work. With Rs. 15,948 spent upon tin-plate, still in stock, these items account for the whole of the increase in the deficit. The possibility of making the department self-supporting depends on the arrest of the declining revenue obtained from the chank fisheries, and upon the early completion of the tank acquisition schemes, the two great sources of income. Reorganization of the cannery, which may involve its removal to a more suitable site, and more enterprise in the conduct of the Tanur Experimental Curing Station are also urgent and should contribute a substantial quota to profits when effected.

The profits derived from the various semi-commercial sections of our work are as follows:—

——	Expenditure.	Receipts.	Profit.
	RS.	RS.	RS.
Chank and beche-de-mer fisheries	43,392	79,928	36,536
Tank stocking operations	57,702	90,484	32,782
Marine aquarium	4,993	10,133	5,140
Pulicat Oyster farm	1,807	2,290	483
Zoological supply	2,975	3,131	156
Marine Fish farm	646	806	160
Total ..	1,11,515	1,86,772	75,257

	RS.
Losses were sustained from—	
Inshore fishing experiments	563
Tanur Experimental Station	136
Experimental Cannery	1,879
Total ...	2,578

In the case of the cannery no real loss has probably taken place, the deficit being due to the large stock of unsold goods being estimated at only two-thirds their selling value. The loss on the Tanur yard is due to the same unavoidable cause as militated against success so adversely in the case of the cannery, namely, the extraordinary scarcity of sardines during the 1920-21 season.

5. *The Director's work apart from administration.*—This has been less than usual owing to my having been on leave for the first $4\frac{1}{2}$ months of the year and to the increase of work due to the reduced assistance I receive from the Personal Assistant whose time is too much occupied with account work. While on leave I was deputed to study fishery conditions in Norway and Denmark and spent over two months on this investigation. The results are embodied in a lengthy report now in the press. Perhaps the most important conclusion arising from this work was the impression gained of the suitability of the Danish seine for introduction to Indian waters. More powerful engines for fish-catching are urgently required and as it appears that steam-trawling on the Madras coasts is too expensive a method under present conditions and too much hampered by other disabilities, the value of a powerful fishing method free from the disadvantages attendant on steam-trawling cannot well be overestimated.

Besides this, I wrote a comprehensive guide to the common shell-fish of South India, to serve as a companion hand-book to the collections of shells intended for supply to secondary schools. The Director of Public Instruction made the writing of this guide a

condition precedent to the placing of an order for a large number of these collections. This book should also prove of considerable value to those who take an interest in the common objects of the sea-shore, for till now, no attempt has been made to provide a popular guide to the shells of South India.

I have also been able to publish, thanks to the generosity of Government, a report upon the *Outrigger Fishing-Canoes of Indonesia*; this appeared as Report No. 2 of Fisheries Bulletin XII. At the science congress held in February 1921 at Calcutta, I also read a paper on *Catamarans and Reed Rafts* as evidence of former race continuity from the Mediterranean eastwards to South America. A summary was published in *Man in India* for June 1921.

Extensive tours have been made, chiefly in the interests of the piscicultural section, to investigate several schemes shortly to be submitted to Government. Special visits were also made to Tanur and Calicut to enquire into the protests made by curers against the imposition of certain of the new rules in force in the fish-curing yards at these places. I was fortunate enough to arrive at a *modus vivendi*, and that good relations, especially at Tanur, have been re-established is evident by the fact that the staff there has not been interfered with by the rioters in the recent disturbances.

My advice has been in frequent unofficial requisition by officers administering fisheries in other Governments. Among these may be mentioned inquiries upon canning procedure from Baroda and Travancore, upon general fishery development in the Seychelles, and upon freshwater pisciculture in Behar and Orissa and the Fiji Islands.

INDUSTRIAL SECTION.

The Experimental Cannery, Chaliyam.

6. *General.*—The year under review was one of those unfortunate lean years experienced occasionally in practically every sardine-canning locality. The catches of sardines were a complete failure, not only in the neighbourhood of Chaliyam but everywhere else on the Malabar coast. Mackerel on the other hand were abundant and the bulk of the goods canned were of this fish. Unfortunately the demand for mackerel is small compared with sardines, and as their keeping qualities are inferior it is not advisable to can beyond a certain limit.

Prawns were also scarce at Chaliyam, and although large quantities were caught at Tanur, the condition of those taken to the Chaliyam cannery was usually such as to preclude their use in canning. This resulted, I believe, from the exceptionally torrid weather which characterized the past season, causing fish and

prawns to taint appreciably more quickly than during normal seasons. To add to the difficulties attending cannery operations during 1920-21, the price of tin-plate rose to an extravagant height and as a large purchase had to be effected at this time owing to depletion of our stock, the heavy cost of this plate has proved a serious handicap and one of the serious causes of the small deficit on the year's working. The quality and packing condition, both of this tin-plate and of a consignment of small tins, were thoroughly unsatisfactory and reflect the unsettled conditions of industrial life in England. So serious were the defects in these consignments that unless conditions improve, repeat orders may have to be placed elsewhere; labour that will not give proper care to the work in hand, cannot expect continued employment; orders are bound to drift to other countries where labour gives proper value for the wages received.

From various inquiries made it is evident that the operations of this department in pioneering a canning industry are impressing other authorities with the commercial potentialities of similar work in their territories. The departments dealing with fisheries under the Governments of Travancore and Baroda have both requested advice in regard to establishing experimental canneries, and besides giving all information possible, it has been arranged to supply can bodies and covers for their preliminary operations.

Sir Frederick A. Nicholson's most useful report on canning practice as applied to fishes has now been issued as Report No. 2 of Volume XIII of our Bulletin. It should prove invaluable as a working hand-book both to our own officers and to all others who contemplate canning enterprises in tropical countries.

7. *Output.*—In spite of all disadvantages, the output was an average one, amounting to 67,524 tins of all kinds. This is a satisfactory advance upon the preceding year, when only 59,586 tins were put up. The bulk consisted of mackerel, with sardines occupying the second position. Prawns were less extensively treated owing to small supplies. Of the larger fish, *narimin* (*Lates calcarifer*) was the only one obtained and canned in any appreciable quantity.

8. *Sales.*—Due to a variety of causes, sales amounted to 35,092 tins only, as against 40,729 last year, leaving a comparatively large balance of 82,152 tins on hand at the end of the year. Although disappointing, the fall in sales is not surprising in view of the chaotic state of the market for canned goods during the year under review; in this connexion it is worthy of note that many canneries in Portugal and the United States have suspended operations owing to the heavy losses sustained during the post-war slump

in trade. So far as India is concerned these adverse conditions may be enumerated as under, namely—

(*a*) a glut of imported goods bought during the months when business was booming and thrown on the markets last year at particularly low prices—often even below cost—in order to obtain ready money to meet business exigencies caused by the financial stringency of recent days;

(*b*) the disposal of large quantities of surplus stores of tinned fish by the Munitions Department at similarly low prices;

(*c*) the sweeping reduction in the number of English troops stationed in India; and

(*d*) the withdrawal by the South Indian Railway Company of the concession enjoyed during previous years of sending canned fish at half parcels rates, coupled with the recent large enhancement of rates plus a surcharge.

In some respects the last of these causes has been the most detrimental, for freight now bears a wholly disproportionate relation to the factory value of the goods, amounting to from 30 to nearly 50 per cent of such value. As a consequence many old customers have ceased to order and others complain of the heavy freight charges.

Efforts have been made to bring the products of the cannery more prominently to the notice of the public and to give an impetus to sales by sending representative samples to local exhibitions, by advertising and by wide circulation of a new price-list got up in attractive booklet form. New and distinctive labels have also been designed and are now in the press. Beyond a temporary fillip, the advertisements have not effected much, apparently due to the heavy railway rates that handicap a direct parcel trade with the populous cities in the north of India. It is evident that a reorganization of selling methods is required; I consider that a Government department should not carry on its sale operations by direct retail trade, but should entrust sales to a restricted number of wholesale agents who already have the machinery required for distribution. But this alternative has its own particular difficulties, for the production of the cannery is after all that of a plant designed primarily for experiment and demonstration; the output is greater than can be disposed of within the Presidency by personal recommendation and at the same time is far too small to be worth the consideration of a wholesale house with business relations throughout India. Such a firm has no use for the limited produce of our experimental plant, which averages only some 700 cases of miscellaneous goods per annum, whereof only some 300 cases are of sardines (the ordinary case of one-fourth size tinned sardines contains 100 tins). Such a production is too paltry for a wholesale firm to consider when it becomes a question of extensive advertisement to push a new and unknown

brand. Even the fact that our goods are of Indian origin is a handicap with those who are not acquainted with them, the general idea, needless to say quite erroneous, being that the high standard of care and cleanliness necessary to ensure a wholesome product is not likely to be maintained under tropical conditions.

At exhibitions held at Mangalore, Tellicherry, Bangalore and Pudukkōttai, highest awards were obtained for the exhibits staged by the cannery.

9. *Finance.* – The total expenditure for the year amounted to Rs. 31,896-4-1 made up of Rs. 1,999-3-8 on capital account and Rs. 29,897 for running charges. Of the latter more than half went in a large purchase of tin-plate bought unfortunately when the market was exceptionally high ; the greater part remains in stock. Against this expenditure, receipts paid into the treasury amounted to Rs. 16,707-1-3, the outstandings Rs. 2,024-15-1 and the value of goods on hand, at two-thirds the sale rates, Rs. 26,160-10-8, leaving an apparent loss of Rs. 1,878-14-11 on the year's working. In actuality there is every probability of the year's operations eventually resulting in a substantial profit, for there is no reason to believe that the goods in stock will be sold at other than their full value, instead of the two-thirds proportion for which credit is now taken. To achieve better results, it appears clear that it will be necessary to remove the cannery to a locality where sardines are either more naturally abundant or the fishermen more numerous and energetic ; supplies at Chaliyam are neither large nor regular, and the consequence is that the staff is intermittantly employed even during the four months that constitute the height of the sardine season. Concurrently reliable agencies must be established for the speedy disposal of the goods manufactured. (Sardines in oil always excepted, for these are not fully matured till 9 months or a year after canning and are said by some French manufacturers to improve even up to a limit of five years from canning.)

Pending the decision of Government on this question no further improvements and additions are being made to the buildings, and no steps have been taken to provide the quarters urgently needed for the Manager, who has in consequence to live at Feroke, two miles up river from the cannery. On several occasions he has been unable to proceed to his work on account of floods in the river, and the hardship of having to go up and down the river twice daily in a dugout canoe in rainy weather is more than should be expected from any man, however willing.

Messrs. Charlton and Cockburn, representatives of the well-known firm of Messrs. Price Waterhouse & Co., Chartered Accountants, London, who are advising the Government of India in respect

to the form of accounts to be maintained by industrial concerns under the Ministry of Development, paid two visits to the cannery to note the system now in use. They also discussed generally the account-keeping of the department with the Director at a meeting at Ootacamund.

10. *Experiments.*—Various experiments were carried on as usual, the chief being directed to the canning of soles, mackerel in oil, and mackerel put up *à la* tamarind fish. In consequence of the unsatisfactory quality of all the curry powders on the market, various trials were made to get one suitable to our special needs and the Manager deserves credit for the excellent result he has now attained. The curried sardines prepared at the cannery and already very greatly appreciated, will certainly be still more in favour in future.

11. *Staff.*—During the year under review Government were pleased to improve considerably the pay of the permanent staff from the Sub-Assistant downwards. The needs of the temporary staff were also duly considered and substantial increases were given to meet the increased cost of living. A bonus on profits, amounting in the aggregate to Rs. 1,014 was sanctioned by Government upon work done during the period 1917–19 and duly distributed to the staff, much to their satisfaction. It is hoped that this concession will bear good fruit in earnest and conscientious work during the coming season.

Tanur Experimental Station.

12. 1920–21 proved even a worse year than its predecessor for the experimental operations carried on at this station in the curing of fish and the production of fish-oil and guano. Both sardines and the larger kinds of fish were extremely scarce, and had it not been for mackerel, of which fairly heavy catches were made, operations would have been trivial. As it was, 97,724 lb. of fish, chiefly mackerel, were purchased for curing, the cost being Rs. 3,242 and the sale-proceeds Rs. 5,802. The market for this cured fish has been extended and local fish dealers are at last beginning to purchase our improved cures of fish for sale at the weekly shandys in the interior: this development is gratifying as it is one that has long been sought; obviously it is of little use to prepare an improved quality of cure if the mass of the people will not touch it, preferring the badly cured and often partially putrid quality to which their vitiated taste has accustomed them. The demand for smoked fish and semi-dried prawns has also increased. Experiments in the moist-curing of mackerel were continued but were hampered by the difficulty of obtaining suitable containers at a reasonable price. The preparation of fish meal for poultry continued and the demand for it is slowly increasing.

13. *Oil and guano operations*—were restricted owing to the dearth of sardines. Only 27·4 tons were purchased as against 260 tons in the previous year. The quantity treated yielded 337 gallons of oil and 4·8 tons of guano. The operations though very small were highly remunerative; the cost of the material was Rs. 406 while sales and stock in hand amount to Rs. 603. The highest rate for guano was Rs. 120 per ton f.o.r. Tanur. The few sardines fished in the past season were extremely rich in their oil content, amounting to as much as 6·3 per cent in December 1920 as against 1·3 per cent in 1919. I had a sample of superfine sardine oil analysed by the Chemical Examiner to Government. Its constitution and characteristics were as follows:—

Specific gravity	0·927
Iodine value	161
Saponification value	196
Free fatty acid (as oleic acid)	0·5 per cent
Colour	Yellow (pale).

The percentage of acidity is considerably lower than is allowed by the British Pharmacopœia for codliver oil, hence it is probable that this oil has equal therapeutic value and may prove an effective substitute for the former; large samples have been sent to the Tuberculosis Hospital for actual trial. The cannery has also successfully employed this quality of oil in the canning of certain descriptions of sardines. It is certain that if oil producers will pay adequate attention to the separation of superfine and No. 1 oils, their enterprise will be richly rewarded. Unfortunately carelessness is prevalent and the factories seldom turn out any but low grades of oil of dark colour and high acidity, and therefore of low industrial value.

The trading accounts of the station show a gross profit of Rs. 425–8–4; after allowance for depreciation and overhead charges, this sum is converted into a small loss of Rs. 135–15–8. The poor result is due entirely to the dearth of sardines which yielded a return of Rs. 603 only as against Rs. 5,171 in the previous year.

14. *Improvement of the oil and guano industry.*—With a view to minimise the nuisance caused to the public by the insanitary working of the oil and guano factories, a set of rules for the guidance of factory owners was approved in G.O. Mis. No. 1381, Revenue (Special), dated 28th July 1920, and the local boards were empowered to enforce them. The taluk boards concerned have accordingly issued licences and appointed Sanitary Inspectors to regulate the working of the factories. As the development of the industry on the right lines is the business of the Fisheries Department, the Government also sanctioned the appointment of an Inspector of Oil and Guano Factories and a fitter to instruct the

factory owners in the right method of manufacture, and to advise them of the importance of placing products of a superior quality on the market, as well as of the danger to the industry caused by adulteration. A thorough inspection of all factories was made and as most of them were found to be very defective, advice as to how these defects could be remedied was given to their owners. Demonstrations of correct processes of manufacture were also given but owing to the scarcity of sardines it was not possible to do this on an extensive scale. There were 646 factories on the coast, of which 387 were licensed, but only 290 factories conducted operations and even these were limited to a couple of weeks' work during the year, on account of the great scarcity of sardines. The total output of guano was estimated roughly at about 1,500 tons, compared with the enormous quantity 24,000 tons manufactured in the previous season. On account of the adulteration of the guano with sand in previous years, there was very little demand for it, and hence, though the output was small, the price offered was very low. In some cases buyers actually preferred beach-dried sardine manure and paid for it even higher prices than for guano. The demand for oil was also very small. Inquiries show that Malabar fish-oil has recently earned, on account of its present low quality and adulteration, a bad reputation in the Calcutta market, where it used to be greatly in demand for batching jute fibre. This department is trying to bring the manufacturers to a sense of the injury they cause to the entire industry by their lack of commercial morality.

15. *Public fish-curing yards.*—The yards under the management of this department were increased by one during the past year, the total now being eight. The quantity of fish brought in for curing was 422,811 maunds; the cured weight was 239,504 maunds, an increase of over 35,000 maunds over the preceding year. 72,065 maunds of duty-free salt were supplied as against 60,061 maunds in 1919-20. The increase in the operations was due mainly to the phenomenally large quantities of mackerel caught at Malpe. The maximum was reached on 16th November 1920, when 7,942 maunds of fish were brought in.

The employment of old brine, filtered for re-use in curing fish, is being gradually introduced, and 28,994 gallons were used for curing 4,442 maunds of fish. Not only does this result in a reduction in the curing expenses; it results in an actual saving to Government of the difference between the cost price and the issue price of the equivalent amount of salt that would be used if this brine were not utilized; last year in spite of the conservatism of curers, who are slow in appreciating the advantage of this procedure, a saving to the curers of Rs. 462 was effected. When this method is systematically

employed throughout all the yards, the resultant saving will be of very considerable importance.

In the Malpe, Mangalore and Thanirbhavi yards, the majority of the curers have put up permanent curing yards, with cemented floors and curing vats, on the models designed by the department. Loans have been sanctioned for the construction of similar ones in the Calicut and Thalayi yards. In the others, pending construction of such permanent structures, the curers were instructed to improve their cadjan sheds in certain inexpensive ways, such as cleansing the floor, providing ventilation and disinfecting the tubs, etc. This caused a strike extending to 2½ months at Tanur. During this period they cured their fish outside the yard with duty-paid salt and undoubtedly spent several times the amount in duty that compliance with the instructions would have cost. Various deputations waited upon me, and only after two visits to Tanur, could I persuade the men of the utility and reasonableness of the innovations. Political influences appear to have been at work, and I believe the majority had no real desire to refuse obedience to the new rules. Similarly a partial strike occurred at Cannanore where ten Mappilla curers stopped work rather than improve their methods, and since then have been curing fish with *duty-paid* bazaar salt.

Now the chief objects in establishing public fish-curing yards are (*a*) 'to prevent the loss entailed on the fishing classes by the purchase of duty-paid salt for curing fish', and (*b*) 'to prevent the injurious effects of the supply of badly-cured fish.' The attitude of the Mappilla curers of Cannanore and Tanur, who are capitalist middlemen, shows that they can make a profit even by using duty-paid salt. Therefore it is evident that they could put up satisfactory sheds and introduce the simple improvements which we advocate, without the least hardship. It is evident that their refusal to do this is due to their desire to make a maximum of profit regardless of the quality of the product. The fact that the department controls only a small number of the total of yards is a handicap to the rapid introduction of improvements, as curers undoubtedly hope to tire out our officers and discredit our work by delaying to carry out improvements—the object being to have the yards reverted to the Salt Department.

Two Assistant Inspectors were transferred to the department, while four temporary yard officers were entertained. All subordinate officers underwent a course of training at the Tanur Experimental Station in improved methods of curing, in the filtration and re-use of old brine and in the estimation of the correct proportions of salt required for different classes of fish. They were specially taught sanitation as applicable to fish-curing yards.

Inshore fishing experiments at Madras.

16. These experiments have now been carried on continuously through a period of three years. In spite of the demonstration that better catches can usually be made by the employment of certain forms of Malabar nets, used in conjunction with large dugout canoes, no Madras capitalist or fisherman has yet been sufficiently impressed to induce him to adopt these methods commercially; all negotiations proved abortive as prospective buyers always saddled their offer with the condition of being permitted to fish inside the harbour. This condition is unacceptable as it would facilitate smuggling.

During the past year of 307 working days, the total quantity of fish caught amounted to 84,786 lb. compared with 114,850 lb. in the previous year. This great falling off is attributed by the fishermen to the abnormally high temperature experienced during the fishing season, a connexion that appears obscure; fish scarcity however was certainly prevalent along the East Coast during the first half of 1921; one consequence of this is seen in the increased number of fishermen from Cocanada and other fishing centres in the north, who went to Burma in search of employment.

The fish caught by our canoes off Madras was sold for Rs. 5,809 as against Rs. 6,404 in the previous year. Expenditure amounted to Rs. 6,295 including an item of Rs. 264 debitable to capital. The loss on the year's working was therefore Rs. 222 exclusive of capital expenditure. The experiment is to be carried on for another six months, in the hope that the canoes and nets may be purchased by local fishermen in the interval.

An extremely useful analysis of the results obtained during the first season's work by sub-assistant M.R.Ry. M. Ramaswami Nayudu, B.A., was published during the year as Report No. 3 of Bulletin No. XII. In it the seasonal variations in the catches of each species of fish are recorded in detail, together with statistics of their relative abundance and other information. For the first time we now begin to have distinct knowledge of the constitution of the food-fish fauna of Madras, and of the relative fishing value of the various nets employed in their capture. This work will be continued. In addition, at the instance of the Hon'ble the Minister for Development, statistics of the fish supplies coming into the city of Madras will be compiled during the coming year. No information on this subject is on record and it is obvious, for many reasons, that exact information should be collected; this information will be particularly useful to any persons or companies who may contemplate the introduction of deep-sea fishing boats. The first requirement of business men in such a case is to have fairly exact knowledge of the extent of existing sources of supply.

PULICAT OYSTER FARM.

17. The past year's operations have been the most satisfactory on record. The 1920 season lasted unusually late, not closing till 24th October; the present year's season opened on 19th March 1921, as against 15th March last year. The condition of the oysters has been satisfactory and demand has increased considerably, 167,000 being sold as against 133,450, the figure for last year. Owing to the increase in railway freight, enhanced prices had to be charged in view of the fact that freight has to be prepaid. Considering the fact that oysters are supplied at the farm at only Rs. 1-3-0 per hundred, the higher freight rates now in force have had fortunately no adverse effect upon demand; as shown above, the farm is now on a financially sound footing. I propose during next season to introduce such changes in the method of distribution as will diminish largely the disabilities at present attendant upon regular and satisfactory supply due to the comparative inaccessibility of Pulicat, whence the oysters have to be brought 16 miles by canal to Ennur Railway Station for despatch to the consignees.

Experiments made during the past season indicate that healthy layings of oysters may be made in special enclosures close to the bar at Ennur. This line of operations will be pursued extensively next year, but no oysters will be put upon the market from this locality until bacteriological examination has proved them to be free from harmful bacterial infection.

The following table shows the details of the past year's operations as compared with those of 1919-20, viz.:—

	1919-20				1920-21		
	RS.	A.	P.		RS.	A.	P.
Receipts	1,715	9	6		2,290	6	0
Expenditure ...	1,860	0	6		1,807	6	3
Loss ...	144	7	0	Profit	482	15	9

A small plot of land has been acquired at Pulicat, on which permanent store sheds will be built, in order to obviate the present inconvenience of renting buildings not entirely suitable for the purpose. With methods of procedure now simplified and adapted to local conditions, and with improved transport arrangements, I look forward to a largely increased output in future years; no food product of the sea can compare with clean-grown oysters for palatability and digestibility, combined with tonic and appetite-stimulating qualities; for this reason they are particularly suitable for invalids and those with jaded appetites. Unfortunately these facts are not sufficiently known and appreciated, hence I propose an active publicity campaign when next season opens; special

emphasis will have to be laid on how they should be prepared for the table—the best of oysters are utterly ruined if the shells be opened roughly and the flesh served up in an unattractive way, as happens so frequently with the ordinary Madras cook who loves to open oysters with a hammer.

THE DEPARTMENTAL MARINE FISHERIES.

18. Of these the only important one at present is the chank fishery, for alike with Ceylon, the pearl fishery has been unproductive for many years whilst that for beche-de-mer is merely an adjunct to the chank fishery, carried on mainly to bring the wages of the Tirupalakudi chank divers to a remunerative level. During the year under notice the decline in the chank fishery noted in 1919–20 continued, and the results both financially and in output were particularly disappointing. The total catch of shells fell to 283,869 compared with 339,835 in the preceding year, and 435,262 in 1918–19. The beche-de-mer fishery was an entire failure.

19. *Financial results.*—The details of the revenue and expenditure for the various chank fisheries for the year are shown below, annas and pies being omitted :—

	Revenue.	Expenditure.	Profit.
	RS.	RS.	RS.
Tinnevelly chank fishery.	35,883	11,158	24,725
Ramnad chank and beche-de-mer fishery ...	30,605	22,528	8,077
Sivaganga chank fishery...	269	264	5
Tanjore chank fishery ...	4,467	...	4,467
South Arcot chank fishery.	1,546	...	1,546
Nellore and Chingleput chank fishery	1,250	...	1,250
Miscellaneous receipts ...	5,909	1,128	4,781
Total ...	79,929	35,078	44,851
Deduct supervision charges	...	...	8,314
Net profit	...	...	36,537

This profit is the smallest for the past seven years and coincides with a marked decline in the number of chanks fished as shown by the following tabulation :—

	Net profits.	Number of shells fished.
	RS.	
1916–17	53,938	418,314
1917–18	57,122	391,137
1918–19	82,611	435,262
1919–20	46,029	339,835
1920–21	36,537	283,869

An investigation of the causes that have led to this great reduction will be undertaken personally by the Director, who has special and long-standing experience of this industry, having reorganized both the Tinnevelly and Ramnad fisheries when those were under his direct control; in the 6 years after the leasing of the Ramnad fishery and ending with 1918-19 a total *net* profit of Rs. 2,75,648 was obtained from these fisheries, while the net profit for the 3 last years of this period when organization was perfected, amounted to the handsome *annual* average of Rs. 64,557. Any considerable fall from this figure entails anxiety, particularly when associated with a great diminution in the number of shells fished. Were it not that we are now receiving the highest price on record for the Tuticorin chanks (Rs. 325 per 1,000, compared with Rs. 99-9-7 when first I took over charge in 1909), the net profit would be still more disappointing.

20. *Tinnevelly chank fishery.*—The year's catch of shells was 109,434 as against 158,941 in the preceding year. In addition, the large number of 23,177 undersized were brought in, a number greater than usual. Special attention must be given next season to prevent these being brought ashore; they are of trivial value to Government and connote an equivalent reduction of the number of valuable fullsized shells available for fishing next season. The fishery commenced on 30th October 1920 and ended on 9th May 1921, the number of non-working days during this period being 59. The maximum number of divers employed was 43 as against 53 last season, and of these only 25 were local men. It is increasingly evident that diving as an occupation is becoming yearly more unpopular in Tuticorin, where less strenuous and more regular employment is open to the sons of divers and fishermen owing to the development of the town as a great shipping and industrial centre. As a consequence, if more divers are to be employed, the system of recruitment from the Ramnad coast must be developed, and to do this, a further increase in the rate paid for shells seems inevitable. Apart from this, the weather conditions were adverse both at the beginning and towards the end of the fishery. Seven hundred and seventy-five shells were collected at Idinthakarai as against 480 last year.

21. *Ramnad chank fishery.*— The total catch for the year amounted to 171,774 as compared with 177,858 shells in the previous season, the details being as follows:—

	1919-20.	1920-21.
Rameswaram	122,880	101,026
South Vedalai and Kilakarai...	10,188	13,879
Pillaimadam	29,055	21,228
Tirupalakudi	15,735	35,641
	177,858	171,774

Unsettled weather and the early onset of monsoon conditions interfered somewhat with the fishery, but the principal reason for the poor catches lay in the lack of success in recruiting an adequate labour force for the Rameswaram section of the fishery. The maximum number of canoes engaged there was 22 as against 32 in the preceding season, which again was less by 11 than the number employed in 1918-19. The decrease therefore has been in progress for two years past. One of the divers was stabbed in the chest by the tail spine of a ray-fish; the alarm at this entailed a few days' cessation of work. Of the 12,375 undersized shells brought ashore, 10,923 were returned alive to the sea, a very satisfactory proportion. For the Vedalai fishery a number of Kilakarai divers were recruited to make good the deficiency caused by a decrease in the number of local men taking part in the fishery. This policy is to be developed further during the coming season, as the offshore beds here are capable of yielding considerably larger quantities of shells than last year's catch. The Tirupalakudi fishery was the only successful one in this section, the catch amounting to 36,641; that for 1919-20 was only 15,735. The men of this place have no other occupation beyond fishing and diving; therefore when chanks are plentiful and promise better returns than ordinary fishing, the chank diving force automatically increases

22. The unimportant *Sivaganga chank fishery* leased from the zamindari for administrative reasons, yielded 2,661 shells, mostly caught in nets. No regular beds are known off this part of the coast and this makes chank fishing as a separate occupation too unremunerative to pursue.

23. *Leased chank fisheries.*—The chank fisheries of the seaboard districts from Tanjore to Nellore inclusive are not susceptible of departmental fishery, primarily because of physical characteristics of the shore line coupled with the strong inshore currents and the frequent turbidity of the water over the chank-bearing bottom. It happens also that several of the nets most commonly used, particularly the thurivalai, sweep the bottom and bring up large numbers of chanks. The system has therefore been evolved of leasing the exclusive right to purchase these shells from the fishermen; the lessee appoints agents in the different villages to receive and pay for the shells. The sums received in respect of the various districts are noted above in paragraph 19. No expenditure is incurred by Government in respect of these fisheries, the whole rental being clear profit. The total amounted last year to Rs. 7,262-12-10. The Fisheries department may justly claim credit for the satisfactory development of this section of its work, for when I took charge of the chank fisheries in 1909, no revenue was derived from any district save Tanjore, where the paltry sum of Rs. 261 represented the total revenue obtained from this source.

24. *Economic condition of the divers.*—This heading will in future disappear, as under orders of Government (G.O. Mis. No. 301, Law, dated 6th May 1921), welfare work among the fishing communities of the East Coast is transferred to the Commissioner of Labour. At the same time every endeavour is and will be made to advance the well-being of these people in every way possible. Connected with this is the advance system under which from time immemorial the divers receive advances from their employers in times of seasonal unemployment and when bad weather interferes with fishing. They also expect and demand advances at the beginning of a fishery to meet the cost of the necessary preparations, including such items as the repair of their boats, the purchase of new gear and a sum to leave behind for their family's expenditure in cases where the fishing is at a distance from their home port. The system when worked sympathetically, as I can vouch it was during the years I had direct charge of the fisheries, is of the greatest value to men who are naturally improvident and whose vocation is an uncertain and seasonal one. Particularly is it of use to the men's wives, who otherwise would be dependent upon uncertain remittances from their husbands when the latter were away from home. It is a counsel of perfection and therefore not practicable in ordinary life, to say that the system should cease and the men be taught to rely upon themselves and to organize co-operative societies to advance monies to members during emergencies. If the men were educated and unprejudiced and thrifty, this desirable arrangement might be possible, but we have to take things as we find them; under present conditions I believe it will be better to increase the rate paid in certain localities as compensation for the rise in the cost of living and to wait till education has made further advance before hastily scrapping a system that has worked satisfactorily in the past and to which the men themselves have a well-marked preference. According to the instructions issued in 1920, special efforts were made during the past year to reduce drastically the sum outstanding as advances; the sum of Rs. 917-13-3 was also remitted under orders of Government. The advances outstanding at the beginning of the year were Rs. 3,618-0-7; with the sum remitted and special strictness in recovery, this amount was reduced at the end of the year to Rs. 1,881-6-4. How far this drastic application of the instruction to recover advances has affected fishery results adversely, it is difficult to assess; the fact remains that reduced catches coincide with unusual strictness in limiting and recovering these advances.

25. *The Beche-de-mer fishery* was a complete failure last season, only 163 lb. being cured. The scarcity has been attributed to heavy mortality due to an unusual influx of fresh water from the

river Vaigai during the last rainy season. The whole cure of the two seasons 1919–20 and 1920–21, was sold last year in Singapore at good rates, but in spite of this and of the sales being in Straits dollars standing at a premium as compared with the depreciated rupee, the transaction involved a loss of Rs. 447–7–5. This unfavourable result was due to deterioration and loss of weight through prolonged storage ; it appears preferable in every way to despatch consignments as ready, without waiting for long periods for some problematic improvement in market rates.

26. *The Pearl Fishery* remains in abeyance owing to the almost complete absence of pearl oysters of any age upon the banks. Here and there, as usual, occasional individuals have been found during the partial inspections which are alone possible pending the re-commissioning of the *Lady Nicholson.* The cost of these and of the upkeep of this vessel amounted in the year under notice to Rs. 8,488–7–9. As Baron Von Imhoff once remarked in a review of the Ceylon administration, "There is more of glitter than of gold about the Pearl Fishery." According to a calculation of probabilities which I made some years ago, we cannot expect another pearl fishery for another 4 or 5 years.

27. *Fishery Vessels.*—During the past year an order was placed for two twin Gleniffer engines each of 60–75 B.H.P., for the re-engining of the *Lady Nicholson.* These have now arrived and will be installed shortly. Thanks are due to the Ministry of Agriculture and Fisheries in London for the kind assistance of their expert in arriving at a satisfactory choice of engine. The *Sutherland*, *Pearl* and *Leverett* have all done good service in the chank fisheries, particularly in the towage of chank divers' canoes to and from the beds : the *Leverett* was especially useful in this way and her services obviated the employment of a hired tug during the Rameswaram fishery, a saving of approximately Rs. 4,000. This however was possible only because of the small number of canoes engaged in the fishery. Had a normal number been employed, a more powerful towing launch would have been a necessity, and the extra profits made would have far exceeded such an expenditure. The *Leverett* is now undergoing alterations which should improve her sea-going qualities. All the above vessels are in good condition, but it is probable that the *Sutherland* will have to be replaced by another and more powerful launch within the next two years, as both her hull and engines begin to show the effects of old age.

The purchase of a sea-going launch capable of being used not only for towage but also in commercial fishing experiments aiming at the introduction of new methods, is under the consideration of Government.

One of the results of my deputation to Scandinavia already mentioned, was a strong recommendation to Government to arrange for exhaustive trials of the Danish seine to be carried out by the Assistant Director of Fisheries (Marine) in selected localities on the Madras coasts. I was particularly impressed with the great catching power of these nets and their apparent suitability for the conditions on certain parts of this coast. They are operated from large motor cutters, provided with motor winches for reeling in the net ropes and for automatically coiling them away. On my suggestion Lieut. Allan was deputed to investigate the details at Esbjerg in Denmark, where this method of fishing was developed. He has reported most favourably on the nets, but is of opinion that the cutters in use in Denmark are not suitable for use under tropical conditions. I hope that the next annual report will chronicle the successful introduction of this powerful net to Indian waters. I may add that recent fishery advices from England mention the success of Danish cutters using this form of seine in competing with the work of steam trawlers. The latter are much more expensive to operate in every way and the former have the advantage of landing their catches generally in better condition than the trawlers. As a consequence, these Danish vessels are able to sell their catches at considerably lower prices than the trawlers. Such boats or a modified type suitable for our somewhat peculiar conditions, seem to me likely to solve the difficulty of how to increase Indian fish supplies. A type of boat suitable for the purpose if built in India should not cost more than Rs. 20,000 fully equipped, a figure that compares most favourably with the Rs. 1,50,000 or more involved in the purchase and equipment of a modern steam-trawler.

MARINE BIOLOGIST'S SECTION.

28. The headquarters remained at Tuticorin as in the preceding year. Work also proceeded upon the same lines. On the research side, the Marine Biologist devoted himself mainly to a continuation of the enquiry into the species of mullets (Mugilidae) found at Tuticorin, to an investigation of the rate of growth among the fishes living in the Silavatturai backwater, to statistical work on the prawns found in the same area, and to the collection of plankton. Upon none of these subjects has a report been furnished, but that upon the mullets is promised for an early date. This should prove of considerable practical value, for at present several species are extremely difficult to differentiate at sight, and as a consequence, there is always some uncertainty in the stocking of fresh water tanks with mullet fry, for certain species readily adapt themselves to a life in fresh water, while others are unable to do so and die off

quickly. Hence the necessity to be able to distinguish readily the species that are tolerant of a fresh water habitat from those which are not. (See remarks on tank stocking with mullet in the Piscicultural section.)

During the year, the Marine Biologist paid visits to a number of coast centres, for the purpose of collecting information and material, while Sub-Assistant M.R.Ry. S. Ramaswami Ayyangar took advantage of the resumption of the annual Laccadive inspection, to accompany the party and thus to obtain further knowledge of the economic possibilities of the islands in respect of marine products. His report is awaited.

The supply of zoological specimens for teaching and exhibition purposes continued to expand, the total receipts amounting to the comparatively large sum of Rs. 3,131–4–0, compared with Rs. 1,608 in the preceding year 1919–20. Comparison is difficult however as last year's figures have been unduly swollen by reason of great increase in the cost of glassware. This, while giving a fictitious idea of rapid progress, restricts sales as the increased cost has to be charged to the buyers; it is hoped that more normal conditions will soon return in the glass trade, and so permit of more real progress being made. The estimated cost of the specimens sent out, including the salary of the Sub-Assistant in charge, amounted to Rs. 2,974–15–9, showing a margin of Rs. 156–4–3 on the credit side.

This work of zoological supply was begun in 1915 by the present Director, who was induced to make this departure by a consideration of the difficulties till then hampering the study of Zoology in Indian colleges. Until then students to a large extent relied upon a study of text-book figures and had little or no familiarity with the animals themselves. They could describe a sea-anemone or a holothurian with exactitude, but would fail to recognize either if they saw them alive in a rock pool on the sea-shore. In the rare instances where more thorough work was done, attention was concentrated either upon land and fresh-water types as more readily procurable, or limited supplies of material were obtained from European Biological stations. The fact that zoological study was hopelessly fettered for want of supplies that lay abundant to hand in our waters, so impressed me at an early date in my fisheries duties that I sought and obtained the permission of Government to begin the supply of zoological specimens to educational institutions throughout India, at rates calculated just to cover the cost of preparation. A clear idea of the utility of the work and of the estimation in which it is held by colleges and schools throughout the length and breadth of India is obtained by an examination of the

value of the specimens supplied during the six years since its inception, viz. :—

	RS.		RS.
1915–16	360	1918–19	1,258
1916–17	576	1919–20	1,608
1917–18	736	1920-21	3,131

The continuous rise in the annual value of the supplies bespeaks not only increasing appreciation by the educational world of India, but also a greatly widened and more solid foundation of the zoological training now current in our colleges.

The improvement of school museums throughout the Presidency is also one of the aims of this branch of our activities. In very few instances are existing school museums of any real educational value; especially is this true of natural history exhibits. If the school be in a coast town, a jumble of unnamed shells, with odds and ends of the flotsam and jetsam of the sea, offends the eye of the zoologist by reason of its utter uselessness. No possible educational value can attach to a collection of shells gathered haphazard and exhibited without order or explanation. To afford remedy in part for this unsatisfactory state of affairs in secondary schools, I arranged some years ago for the preparation of compact wall cases containing named selections of typical Madras shells. The Director of Public Instruction warmly approved of the scheme, and promised to order a large supply of these collections provided that a descriptive hand-book be prepared. It was difficult to find time in which to write such a description, for nothing of the kind has hitherto been attempted, but I have now completed the task and the report is in the hands of the printer. I hope shortly to complete a companion work on South Indian crustaceans to illustrate a typical collection of our common crabs.

This supply work benefits the whole of India; indeed it is the colleges in the north of India that take chief advantage of the facilities provided. In these circumstances it would appear fitting that the Government of India should be asked for a contribution towards the development and extension of an educational service that has unanimous approval and support from practically every college in India where zoology is a subject of instruction.

His Excellency Lord Willingdon, Governor of Madras, accompanied by Her Excellency Lady Willingdon, honoured the Tuticorin Biological Laboratory with a visit on 31st October 1920; the various collections were shown to them and the scope and nature of the current investigations explained.

29. *Krusadai Island Biological station* progressed during the year. With the exception of the main building which still requires

roofing, all the others were completed ; this station is ideally situated for biological investigation, as the island is margined by a fringing coral reef with a rich mud-bank fauna within a mile distance on the north side and deep water, characterized by profuse and diversified bottom life, adjacent to the south beach. The completion of the buildings will mark the realization of the hopes of all zoologists who have had the privilege of pursuing their studies on the coast of South India. They will also provide useful headquarters for the Department's Fishery Inspection vessel, as the anchorage in front of the station is the best and most sheltered of any along the south-east coast, with the added advantage of central position, being midway between our chank fisheries in the Gulf of Mannar and Palk Bay.

MADRAS MARINE AQUARIUM.

30. The aquarium on the Marina continues to maintain its claim to be among the foremost popular resorts in Madras ; the extra expenditure authorized by Government for the purpose of adding to its amenities and attractiveness has again been justified by a maintenance of the phenominal increase in attendance and gate money which occurred when it was transferred to 'Fisheries' as shown below :—

	1918–19.	1919–20.	1920–21.
Number of visitors ...	96,957	163,517	161,699
	RS.	RS.	RS.
Admission money ...	3,783	9,380	9,772
Expenditure	2,064	4,861	4,993
Profit ...	1,719	4,519	4,779

To this profit has to be added miscellaneous receipts amounting to Rs. 130 and the value of the guide-books and other publications sold, amounting to Rs. 231–10–0. The Pongal festival again gave the highest attendance, as many as 4,963 visitors having paid for admittance on Kannu Pongal day, as against 4,104 in the preceding year. Among the distinguished visitors during the year was His Royal Highness the Duke of Connaught, who was accompanied by His Excellency Lord Willingdon, on 12th January 1921. The Hon'ble the Minister for Development, who takes a great interest in the success of the aquarium, has also paid several visits of inspection.

Improvements effected comprised the construction of a small laboratory room for the use of the officer in charge, and of further additions to the electric lighting of the tanks and of an electric signboard at the commencement of the pathway to the building.

The tank lighting improvement consisted of the installation of two shaded lights in front of each tank, in order that the paintings and legends in the frames along the upper margin of the tank front should be visible during the evening illumination. The practical utility of the two latter improvements is shown by the fact that the evening attendance rose from 7,742 (receipts Rs. 1,938-6-0) in the year 1919-20 to 10,429 (receipts Rs. 2,584-13-0) in the past year.

The construction of a filter well at the margin of the sea to improve the quality of the water in circulation was commenced.

The sale of the second edition of the Aquarium guide, priced at 2 annas, continued slow, only 637 copies being sold till 16th December 1920. On a representation to Government of the advantages of stimulating the interest of the general public in the life of the common fishes of our seas, Government were pleased to authorize a reduction in price to the more popular one anna; immediately sales rose and during the next six months over 2,000 copies were sold, the total for the year being 2,913 copies. A third edition will shortly have to be issued. To cater for the non-English reading public, an edition in the vernacular (Tamil) has been prepared, and was placed on sale on 21st July 1921.

31. *Research.*—Mr. S. T. Moses, the Sub-Assistant in charge, took up fresh subjects for investigation during the year—the anatomy of the ocellated Sea-Hare (Notarchus) and the habits of the paddy-cutting crabs. The latter is a subject referred to Fisheries by the Agricultural Department, who seek a means to diminish the damage caused in certain places by this pest. Unfortunately the demands made upon his time by routine duties and by teaching work in connexion with the training of probationary fishery inspectors at the Ennur Institute have seriously restricted the time available for such researches.

32. *Museum specimens.*—The same Sub-Assistant undertakes the preparation of Museum exhibits of Madras crabs and other large crustacea. A considerable number of specimens were despatched to various colleges and museums; the profits on these have hitherto been credited to the Tuticorin Biological Laboratory, but should properly be shown under aquarium receipts.

INLAND PISCICULTURE.

33. This section progressed most satisfactorily during the past year and has given excellent results both on the research and development sides. The four Assistant Inspectors sanctioned by Government in April 1920 were duly appointed and they have undergone an extensive course of training in the theory and practice

of pisciculture during the past year. I placed the Ennur station at the Assistant Director's disposal for this purpose, and it bids fair to form the nucleus of that training institute so greatly needed for the instruction of the department's subordinates. The present students, besides pisciculture, have had instruction in elementary zoology, and in surveying, levelling, account keeping and office routine. Such trained men should enable the department to make more rapid and thorough progress on the piscicultural side than has been possible in the past.

34. *Tank acquisition and stocking.*—In accordance with my programme initiated two years ago, these operations are now being taken up systematically, district by district. During the past year possession was obtained of the 135 tanks acquired under Government sanction from the District Boards of Nellore and Chingleput. Stocking was duly carried out and it is satisfactory to find that in the case of the fishery sale of those tanks attended by the department's officer specially deputed to this work, the revenue obtained amounted to Rs. 2,849 against compensation payable of Rs. 1,066-8-0. Those sales which could not be attended, on the other hand, brought in a total of only Rs. 7,855-4-0 against compensation payable of Rs. 8,101, a fact that emphasizes the need for the department's officers to be present at all auctions, as they only have direct interest in ensuring that there be healthy competition among bidders, and in refusing bids which are obviously inadequate. The rentals of a number of tanks and channels in the Coimbatore district supplied from the Cauvery and Bhavani rivers were also provincialized during the year (G.O. Mis. No. 520, Development, dated 5th April 1921) as from 1922-23, and an annual compensation of Rs. 1,893 assigned to the District Board in consideration thereof.

The total revenue derived from the fishery sales of all inland waters under our control amounted during the past year to the handsome figure of Rs. 90,484-3-0 as against compensation payable to district boards of Rs. 55,959-14-0. These figures compare with rentals realized in 1919-20 of Rs. 75,956-3-6, and compensation payable of Rs. 44,946-14-0. The increase in revenue and in profit from this source is most gratifying and betokens the intrinsic value of the department's operations in this promising field of work.

The district of Ganjam has been surveyed during the past year, and a scheme for the acquisition of the fishing rights in its principal tanks and streams is under preparation.

35. *Fish farms.*—During the year the three established fish farms at Sunkesula (Kurnool), Ippur (Nellore) and Perambur continued their work satisfactorily. It is unnecessary to go into details as the work done there has now settled into routine, and to give particulars would merely be to recapitulate the paragraphs in last year's report.

The difficulties experienced at the *Sunkesula farm* increase, partly because of the restricted area of the ponds available now that our operations have increased beyond all original expectations, and partly because of the high cost entailed by the pumping operations necessary to keep the ponds properly supplied with fresh-water during the hot weather. It has become necessary to find a site where operations can be carried on both more extensively and more economically. Unfortunately the only possible site is one at Mahanandi, in proximity to the temple, and although the temple authorities originally agreed to the construction of the farm, they have lately demurred until the purpose of the farm is clearly defined and certain assurances given that under no circumstances will fish be killed at the farm. The matter is under negotiation.

As in previous years the market at Kurnool was supplied with fish reared in the Edurur swamp: 595 lb. of Murrel and 774 lb. of Carp and other fish were thus distributed.

The stock of Gourami at Sunkesula continued to do well, and bred twice during the year. Etroplus also bred prolifically, and the fry were extensively distributed to various tanks.

36. At the *Ippur farm*, the few Etroplus introduced during the previous year multiplied exceedingly, a result due to the provision of special facilities for them to nest. Their fry have been distributed to the irrigation tanks under our control in the Nellore district. A large quantity of Haplochilus was also supplied from this farm for antimalarial stocking purposes, to the officer in charge of the Station Hospital at Secunderabad.

None of the Gourami bred at Ippur, and it appears certain that some conditions are adverse. I have suggested that perhaps the ponds are too large, as this fish breeds freely in quite small ponds at Perambur and Sunkesula. This modification will be tried next season.

37. The *Perambur farm*, where both Gourami and Etroplus breed freely, has now become too small for our operations. Another site was sought and has been found in the extensive borrow pits at the Government brick-fields at Chetpat, which hold permanent water and are otherwise eminently suitable for our requirements. The Chief Engineer to Government has kindly placed several of these ponds at our disposal, as the site is shortly to be abandoned owing to the exhaustion of the available clay. The Corporation of Madras appear to have pressed for the filling up of these ponds on sanitary grounds, a procedure that would entail a prohibitive expense. It is therefore in the interests of all concerned that the ponds be managed by 'Fisheries', as we can, at insignificant expense, and with considerable advantage to fishery schemes on hand, utilize this large

area for the culture and distribution of food fish, fry and larvicidal fishes. When the ponds are cleaned out and remodelled, it is proposed to transfer the Perambur fish-farm operations entirely to this centre, where supervision will be easier and the area of culture-water many times increased. Proposals will shortly be submitted.

38. *Prema larvicidal fish-farm.*—The two ponds at this centre continued to provide large supplies for stocking the Nallamalai waters. During the year under report all permanent waters in the Bairluti, Pecheruvu and Gundalakamma ranges and one spring in the Chelma range were stocked with larvicides. An extension of the ponds has become necessary to meet the increased volume of operations. Plans and estimates for these have been prepared.

39. *Acclimatization.*—This work proceeded as in the year preceding, but on a larger scale. *Etroplus suratensis* bred prolifically in all our three fish-farms, and its wide distribution to inland waters should soon make it well known in places where none existed a couple of years ago. This result emphasizes the value of biological research, for it was not till the life-history of this fish had been fully investigated, that we were able to provide the breeding fish with nesting places suitable for its peculiar requirements. The stock of Gourami is steadily increasing at Sunkesula and Perambur and it will soon be possible to utilize its fry in considerable numbers for stocking purposes.

The use of the fry of certain species of Mullet, begun in 1919-20, has been largely extended. Samples of the fry employed for this purpose, kept under observation in the Ippur fish farm, were found to have grown from sizes ranging between 2 and 5½ inches in length, to 8 and 11 inches within a period of ten months, in June 1920. In the year now closed these same fish attained sizes ranging between 15 and 16 inches in length. Mullet that can be acclimatized to fresh water have many other advantages besides rapid growth. Their fry are extremely abundant in estuaries; they are easily captured and transported; they are chiefly vegetarian in diet and are esteemed highly as food, fetching better prices, weight for weight, than coarse tank fishes.

The valuable carp, *Catla catla*, is another fish that will repay effort to extend its area of distribution south of Madras where it does not naturally occur. Difficulty had been experienced in finding its breeding places and the haunts of its fry. Recent research has been successful in locating abundance of fingerlings in the Colair lake region and a proposal for establishing a fishery station in Colair lake is now under preparation.

40. *The Hilsa Hatchery* at the lower anicut could not be operated in 1920 owing to the lack of ripe fish. Attention was therefore concentrated upon a search for fry and young fish. Considerable success was achieved, young hilsa, between 57 mm. and 75 mm., being captured for the first time in channels above the anicut. Another set, ranging between 92 mm. and 130 mm., was secured from other channels. A study of the scales of hilsa has been commenced by Mr. Sundara Raj with a view to determine the age of breeders and the time the young spend in fresh water before going down to the sea. Considerable progress has been made and already several generally accepted preconceptions have been found erroneous.

41. *Incomplete schemes.*—The fish farm at Mopad is nearing completion. Stocking operations will probably commence within the next few months. The Kanigiri-Duvvur scheme was sanctioned for an experimental period of three years in May 1919, but so far the detailed plans and estimates have not been received from the Public Works Department.

The Chingleput and the Vellore moat schemes are two projects important both from the sanitary and the piscicultural standpoints. In each case, a considerable population lives within the fort and has suffered much from malaria in the past. In the case of Chingleput construction work was started during the past year, while at Vellore preliminary work was done in the clearing out of the masses of water hyacinth that choked the moat. The clearance of these weeds has, as at Chingleput, already yielded results mitigating largely the former mosquito plague, but no permanent good will result till the works be completed and the moat stocked with fish suitable for keeping down the growth of vegetation and for destroying mosquito larvæ.

42. *Research.*—Owing to the restriction of practical work in several directions due to financial stringency, more time than usual was available for the investigation of the life-histories of food fishes. Considerable progress was made, as already mentioned, in the study of the early stages of hilsa; the nesting habits of the Gourami were further studied and also the breeding habits of two of the largest catfishes found in the Cauvery (*Macrones aor* and *M. seenghala*).

Encouragement has been given to others working on the same lines, and I am glad to record that Mr. N. P. Panikkar, F.L.S., Inspector of Fisheries, Travancore, and a former student of this department, has furnished a valuable and interesting account of the breeding habits of the two species of *Etroplus* found in Travancore. With the sanction of the Madras Government, this most useful paper has been published as a constituent report (No. 5) of Volume XII of our Fisheries Bulletin. It is indeed encouraging to find valuable

research work of high economic importance being done by men whose training has been received wholly in India. I refer especially to the investigations of Messrs. Sundara Raj, N. P. Panikkar, S. T. Moses and M. Ramaswami Nayudu.

SOCIO-ECONOMIC SECTION.

43. *Co-operation.*—(*a*) At the beginning of the year there were 47 fishermen's co-operative societies, including two productive societies, with a membership of 2,827. Of these forty-one were on the west coast and six on the east coast. Their number rose to sixty-nine at the end of the year and the membership to 3,544 (fifty-six being on the west coast, and thirteen on the east coast). The paid-up share capital of these societies also rose from Rs. 49,232 to Rs. 66,585 and the loans disbursed from Rs. 1,17,520 to Rs. 1,69,103. The two productive societies, viz., the Melady and Madapalli fish-curers' co-operative societies referred to in last year's report, were registered during the year but have not started work as the fish-curing yards in these two villages have not yet been opened. Four other societies which have been registered also remain to be started. The following table contains the more important figures relating to the working of these societies :—

	1918-19.	1919-20.	1920-21.
Number of members { males	1,644	2,446	3,099
Number of members { females	256	381	445
Total	1,900	2,827	3,544
Number of shares	2,438	3,832	4,875
Paid-up share capital	RS. 25,388	RS. 49,232	RS. 66,585
Loans disbursed	40,511	1,17,520	1,69,103
,, for payment of prior debts	8,736	17,866	26,318
,, for industrial use	..	26,410	61,788
Loans due to the Central Banks and other depositors.	4,714	27,994	18,253

(*b*) The total borrowings of societies during the year 1920-21 amounted to only Rs. 7,410. At the end of the year the balance of loans due to Banks and others was Rs. 18,253. Of these Rs. 10,050 is the amount due by the Mangalore Guano Factory owners' co-operative society. This society did little or no business during the year and a commission of Rs. 99-4-4 collected was the only income it derived. The decrease of business is due to the failure of sardines during the year and also to want of experience and interest on the part of the office-bearers to carry on the business in a properly organized manner. The Co-operative and Fisheries Departments have jointly formulated a scheme for the better working of this society but it has not yet been accepted by it.

(*c*) The Thalayi Fish-Curers' co-operative society was not able to carry on joint sale for want of experienced men to manage its business, and as they could not utilize their paid-up share capital for this purpose, they have resolved to give this amount as loans to the members for their individual business till they gain some experience in the fish trade. It nevertheless collected a commission of Rs. 225-7-5, on the fish sold individually by the members and also refunded Rs. 512-11-9 towards the cost of the site acquired and of the building which Government put up for its use.

(*d*) The society of Uppalavadi has purchased a plot of land for Rs. 1,050 with the help of a loan from the Central Bank and secured a licence from the Cuddalore Municipal Council for opening a fish market thereon. This will not only enable them to get proper prices for their fish but also bring in a rent of about Rs. 40 per mensem. This is a noteworthy instance of a very humble, illiterate, and backward community who have improved their economic condition and status in a substantial manner by co-operation, though it is only two years since their society was started.

Another interesting society is the one organized for the stipendiary students of the Fisheries Training Institute.

On account of the slackness that prevailed in some of the societies, it was found necessary to consolidate them rather than to increase their number by starting others. There were also factions in a few of the villages which prevented the smooth working of their societies. Most of them have nevertheless worked satisfactorily making due allowance for the inexperience and illiteracy of the great majority of the members.

44. *Education.*—The Training Institute at Calicut continued to progress satisfactorily. Twenty-four pupil teachers were under training. Besides undergoing instruction in the syllabus subjects (except carpentry) they were given opportunity by means of frequent excursions to acquire practical knowledge of the principal methods of fishing and curing as practised on the west coast, including canning, smoking and the like.

Three canoes fully equipped with fishing gear were available for their use; they were regularly sent to sea in batches several times a week during the fair weather period to gain first-hand experience. The Headmaster is to be congratulated on the good progress made by his pupils.

45. *Village schools.*—The number of these schools rose from 20 to 28. Of these fifteen are day and thirteen night schools. The number of pupils rose from 929 (565 day and 364 night) to 1,385 (930 day and 455 night) and out of this total 285 were girls. The number of teachers employed by the department was 38 in the day

schools and 23 in the night schools. As in the previous year most of the new schools were started and worked by the villagers them selves for several months, and were taken over by the department only after being satisfied of the need for such schools in these localities. Similar applications were received from several other villages for the opening of schools, but on account of financial considerations no action was taken. Most of the schools are accommodated in temporary sheds or other unsuitable buildings and much inconvenience is felt for want of proper buildings. All the schools were inspected in the course of the year by officers of the Fisheries Department as well as by Sub-Assistant Inspectors and Supervisors of the Education Department.

46. *Temperance and other socio-economic work.*—Temperance work made further progress, especially in South Kanara where a large number of fishermen in the Udipi and Mangalore taluks have voluntarily abandoned toddy drinking. In some villages they have gone still further and have adopted objectionable 'coercive methods in their otherwise laudable desire to encourage thrift; in several instances caste panchayats have even passed resolutions prohibiting members from resorting to tea and coffee shops on the ground that much money is wasted in this way. It is hoped that the officers of the department will exercise their influence against such compulsory sumptuary rules and encourage the men to practise thrifty and temperate habits from conviction and not merely because of orders issued by the panchayat. Compulsory thrift and temperance invite a reaction sooner or later, and I consider that such artificial devices to uplift the working classes of the country should be discouraged. Let education, precept and example be the levers employed.

On the east coast the Assistant Director of Fisheries (Coast) visited several villages on propaganda work, but the results were unsatisfactory owing to the failure of the season and the existence of factions. In future, socio-economic work among the east coast fishermen will be carried on by the Labour Department.

As a result of representations made by this department from time to time, representatives of the fisher communities have been nominated as members upon most of the maritime taluk boards and municipal councils. A few have been appointed Honorary Magistrates and one has been nominated to a seat in the Madras Legislative Council.

General.

47. The conduct of the staff has been generally satisfactory and those at headquarters have my special sympathy owing to the unpleasant conditions under which they have to work. I am glad

to report that the Personal Assistant, Mr. U. Karunakara Menon, duly completed his term of training in co-operative work prescribed by the Registrar of Co-operative Societies, who states that the officers with whom he worked reported in very appreciative terms on his progress and of his keenness and capacity.

Mr. J. A. Fernandez, who acted for Lieut. Allan, Assistant Director of Fisheries (Marine), rose to the occasion and demonstrated the ability of a member of the sea-faring Parawar community for difficult administrative duties. I believe that Mr. Fernandez is the first member of his community to hold a post of such responsibility under Government, and it gives me much pleasure in bringing his services to the notice of Government.

48. The usual statements are appended.

JAMES HORNELL,
Director of Fisheries.

Statement I.—Summary of expenditure and receipts of the Fishery Department, 1920–21.

Particulars.	Expenditure.	Receipts.	Difference.
	RS. A. P.	RS. A. P.	RS. A. P.
I. Supervision and Research ..	1,13,820 14 6	3,645 0 7	— 1,10,175 13 11
II. Marine Fisheries	62,403 9 7	99,416 9 7	+ 37,013 0 0
III. Inland Fisheries	70,256 15 5	90,868 8 10	+22,612 9 5
IV. Factories	43,763 9 3	35,489 6 4	— 8,274 2 11
V. Capital expenditure	2,782 11 5	..	— 2,782 11 5
Total ..	2,93,026 12 2	2,29,419 9 4	— 63,607 2 10

Statement II.—Details of expenditure.

Particulars.	Capital Expenditure.	Running expenditure.					Total.
		Salaries.	Establishment.	Allowances.	Supplies and services.	Contingencies.	
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
I. Supervision and Research	7,309 10 11	32,334 8 6	40,785 11 9	21,247 3 10	8,738 4 11	10,715 1 6	1,13,820 14 6
II. Marine Fisheries	6,066 4 9	4,922 3 10	13,903 7 4	1,694 12 5	36,082 2 3	5,800 15 9	62,403 9 7
III. Inland Fisheries	10,679 2 1	865 0 0	1,992 13 9	..	67,398 1 8	..	70,255 15 5
IV. Factories—							
(*a*) Cannery	1,999 3 8	2,520 0 0	2,997 7 7	..	29,552 6 10	435 0 0	35,504 14 5
(*b*) Tanur	1,772 13 0	..	1,653 9 5	..	6,355 1 5	250 0 0	8,258 10 10
Total Capital expenditure ..	27,827 2 5	..	..	..	..	..	..
Depreciation and interest on above at 10 per cent.	2,782 11 5	..	..	..	..	..	2,782 11 5
	2,782 11 5	40,641 12 4	61,333 1 10	22,942 0 3	1,48,126 1 1	17,201 1 3	2,93,026 12 2

Statement III.—Details of Receipts.

I. Supervision and Research.

	RS.	A.	P.
(a) Receipts being rent realized from Ennur Bungalow.	106	8	0
(b) Receipts from sale of zoological specimens.	3,131	4	0
(c) Miscellaneous receipts.	407	4	7
	3,645	0	7

II. Marine Fisheries.

	RS.	A.	P.
(a) Receipts from all chank fisheries including beche-de-mer fishery as per Statement IV.	79,928	8	5
(b) Receipts from Pamban Pearl Farm.	63	8	4
(c) Receipts from Marine Fish-farm.	806	2	10
(d) Receipts from Marine Aquarium.	9,771	9	0
(e) Receipts from Pulicat oyster farm.	2,290	6	0
(f) Inshore fishing receipts.	5,809	5	3
(g) Miscellaneous receipts—			
(1) Aquarium guides and other pamphlets.	231	10	0
(2) Aquarium shop rental.	130	0	0
(3) Miscellaneous Pearl Fishery receipts.	385	7	9
	99,416	9	7

III. Inland Fisheries.

	RS.	A.	P.
(a) Rentals from tanks and rivers, etc., the fisheries of which were taken over by this Department—vide Statement V.	90,484	3	0
(b) Receipts from Sunkesula farm.	221	12	2
(c) Receipts from sale of larvicidal fish.	127	8	3
(d) Receipts from Powder factory fish-farm.	1	5	9
(e) Miscellaneous receipts.	33	11	8
	90,868	8	10

IV. Factories.

	RS.	A.	P.	RS.	A.	P.
A. Cannery—						
(1) Actual receipts (amount remitted into Treasury) from sale of canned fish.				16,707	1	3
(2) Amount outstanding—						
On 1st July 1921.	2,024	15	1			
Do. 1920.	1,284	13	2			
	740	1	11			
Deduct collected in advance.	17	11	0			
	722	6	11	722	6	11
(3) Value of goods on hand—						
On 1st July 1921.	26,160	2	8			
Do. 1920.	16,755	12	8			
Difference ..				9,404	6	0
				26,833	14	2
B. Tanur—						
(1) Actual receipts				9,517	14	8
(2) Amount outstanding—						
On 1st July 1921.	913	4	3			
Do. 1920.	1,193	5	3			
Difference ..				— 280	1	0
(3) Value of goods on hand—						
On 1st July 1921.	1,487	4	0			
Do. 1920.	2,069	5	6			
Difference ..				— 582	5	6
				8,655	8	2

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Statement IV.—Profit and Loss account of the Chank and Beche-de-mer fisheries for the season 1920–21.

Expenditure.	Amount. RS.	A.	P.	Receipts.	Amount. RS.	A.	P.
Chank Fisheries—				Value of chanks fished—			
Tinnevelly	11,158	5	10	Tinnevelly	35,883	4	11
Ramnad	18,294	13	2	Ramnad	30,545	11	1
Sivaganga	264	1	0	Sivaganga	268	12	2
Beche-de-mer fishery ..	233	8	1	Beche-de-mer fished ..	58	14	6
Eighth year's proportion of the total consideration paid in 1913–14 for a 15 years' lease of the Ramnad fishery.	4,000	0	0	Chank rentals received—			
				Tanjore district	4,466	10	4
				South Arcot district ..	1,546	2	6
Law suits expenses, Messrs. J. B. Dutt & Sons.	1,128	1	6	Chingleput and Nellore districts.	1,250	0	0
Supervision charges, viz :—pay and travelling allowances of Assistant Director (Marine), 50 per cent of pay, travelling allowance and contingencies of subordinate staff.	8,313	8	0	Godown rent and interest received from Messrs. J. B. Dutt & Sons.	5,909	0	11
The balance of profit is ..	36,536	2	10				
	79,928	8	5		79,928	8	5

Statement V.—List of tanks and canals stocked by the Fisheries Department with the compensation paid and rentals realized for the year 1920-21.

	Fishery rental.			Compensation.		
	RS.	A.	P.	RS.	A.	P.
1. Singanamalla tank	200	0	0	117	0	0
2. Ellanur tank	100	0	0	...		
3. Kamalapuram tank	1,625	0	0	500	0	0
4. Daroji tank	216	10	8	155	0	0
5. Chembarambakkam tank ...	1,050	0	0	2,195	0	0
6. Madurantakam tank	550	0	0			
7. Kandakur Vyasasamudram tank...	90	0	0	200	0	0
8 Rangasamudram	11	0	0			
9. Tippasamudram	11	0	0			
10. Tsadam	8	0	0			
11. Peddi Naidu tank...	11	8	0	...		
12. Markapur tank and supply channel	155	0	0	95	0	0
13. Kurnool-Cuddapah canal including three canals	3,811	2	0	2,553	14	0
14. Venkatapuram tank	95	0	0	...		
15. Siddapuram tank	18	0	0	...		
16. Belegal tank	...			16	0	0
17. Badakan tank	...					
18. Kocheruvu tank	16	0	0	...		
19. Kanigiri reservoir	1,750	0	0	1,755	0	0
20. Gudur tank	120	0	0	...		
21. Karedu tank	24	8	0	117	0	0
22. Puduparti tank	...			5	0	0
23. Ippur Kamini tank	...					
24. Kaveripakkam tank	4,176	10	8	3,789	0	0
25. Dusimamandur tank	2,335	0	0			
26. Baruru tank	98	0	0	100	0	0
27. Three tanks under Barur ...	71	0	0	20	0	0
28. Penukondapuram tank	110	0	0	118	0	0
29. Panjampatti tank	16	0	0	...		
30. River channels in Trichinopoly ...	289	6	0	...		
31. Cauvery and Coleroon	62,221	5	8	34,924	0	0
32. Chingleput and Nellore tanks ...	10,704	0	0	9,300	0	0
Total ...	90,484	3	0	55,959	14	0

Statement VI.—Trading account of the Government Fisheries Cannery, Chaliyam, Malabar, for the year 1920–21.

	RS.	A.	P.	RS.	A.	P.
To stock of canned fish on 1st July 1920 ..	14,756	9	9			
To stock of guano, oil and empty tins, etc. ..	84	8	7			
To stock of empty tins manufactured at the cannery.	1,914	10	4			
				16,755	12	8
To cost of solder, tin-plate, empty cans (imported), tin and manufacturing sundries used.	13,174	10	7			
To cost of fuel	1,017	11	5			
To cost of fish used for canning and curing ..	2,406	6	8			
To cost of condiments and packing oil ..	1,379	13	9			
To cost of sundry miscellaneous stores ..	134	4	1			
To cost of salt and preservatives	65	3	5			
To cost of packing materials	415	12	0			
To cost of labels and rubber rings	234	13	0			
Wages of temporary staff and extra labour ; 50 per cent only debited.	1,981	14	7			
Railway freight	1,649	2	11			
				22,459	12	5
Gross profit (transferred to Profit and Loss Account). ..				4,374	9	9
				43,590	2	10

	RS.	A.	P.	RS.	A.	P.
By sale of canned fish remitted to Treasury from 1st July 1920 to 30th June 1921.	16,033	3	9			
By sale of cured fish	86	7	8			
By sale of prawn shells	17	13	0			
By sale of tin scrap, empty tins, etc. ..	27	1	0			
By sale of fried and fish oil	77	0	0			
By sale of pit manure	46	3	9			
By sale of miscellaneous articles	419	4	1			
				16,707	1	3
To amount collected and remitted into Treasury against the previous year's sales.	1,284	13	2			
To amount collected in advance and remitted into Treasury against future orders.	17	11	0			
				1,302	8	2
				15,404	9	1
By value of canned fish, etc., sold but proceeds not remitted to Treasury on 30th June 1921.				2,024	15	1
By value of manufactured goods on hand on 1st July 1921—						
Canned fish	23,778	14	10			
Guano	112	0	10			
Tin scrap and empty tins	1	8	0			
Fried oil	6	0	0			
Fish oil	18	0	0			
By value of empty cans manufactured at the Cannery on hand on 1st July 1921.	2,244	3	0			
				26,160	10	8
				43,590	2	10

Statement VII.—Profit and Loss account of the Government Fisheries Cannery, Chaliyam, for the year ending 30th June 1921.

	RS.	A.	P.		RS.	A.	P.
To pay of permanent staff, viz., Manager, Sub-Assistant, Mechanic, Canning overseer, three clerks and one peon (50 per cent only debited).	4,316	9	6	By gross profit transferred from Trading Account.	4,374	9	9
To service stamps ...	505	12	0	Loss	1,878	14	11
To depreciation and interest at 10 per cent (13, 680—1,368 + Rs. 2,000 at 10 per cent).	1,431	3	2				
	6,253	8	8		6,253	8	8

Statement VIII.—Trading account of the Tanur Experimental Station for the year ending 30th June 1921.

Particulars.	Amount. RS. A. P.	Total. RS. A. P.
To stock of cured fish on hand on 1st July 1920.	243 4 0	
To stock of fish guano on hand on 1st July 1920.	214 7 3	
To stock of fish oil and foots on hand on 1st July 1920.	442 5 2	
To stock of prawn shells on hand on 1st July 1920.	36 11 1	
To stock of pit manure	136 8 0	
To stock of expendible stores, e.g., salt, fuel, etc.	996 6 0	
		2,069 9 6
To charges (1st July 1920 to 30th June 1921).		
Establishment (temporary) wages (only 50 per cent debited) Rs. 929-14-7. Wages for coolies on muster rolls and over-time bills Rs. 798-1-10.	1,728 0 5	
To cost of fish for curing	3,241 11 6	
To cost of fish for oil and guano operations.	406 4 0	
Fuel	166 6 5	
Saw dust	1 15 0	
Packing materials	346 10 3	
Railway freight on cured goods	596 12 6	
Petty coolie and carriage	358 7 1	
Sundry stores	184 6 6	
Salt and preservatives	61 10 4	
Miscellaneous	223 9 6	
		7,315 13 6
Total ..	..	9,385 7 0
To gross profit ..	..	425 8 4
Total ..	..	9,810 15 4

Particulars.	Amount. RS. A. P.	Total. RS. A. P.
By sale of cured fish remitted into Treasury from 1st July 1920 to 30th June 1921.	5,802 7 3	
By sale of fish oil and foots	386 15 2	
Do. fish guano	497 3 10	
Do. prawn shells	151 14 2	
Do. pit manure	146 8 0	
Do. fish meal	77 10 6	
Total book adjustments	1,541 1 5	
	8,603 12 4	
Deduct outstanding shown in 1919-20 accounts.	1,193 5 3	
		7,410 7 1
By value of stock on hand on 1st July 1921—		
Cured fish	160 15 0	
Fish oil and foots	177 0 0	
Prawn shells and fish manure ..	9 9 0	
Fish guano	198 15 0	
Expendible stores, e.g., salt, fuel, packing materials, etc.	940 13 0	
		1,487 4 0
By value of goods sold but not realized on 1st July 1921.	..	913 4 3
Total ..	..	9,810 15 4

Statement IX.—Profit and Loss account of the Experimental Station, Tanur, for the year ending 30th June 1921.

Expenditure.	RS.	A.	P.
To rent due for Bangalore stall	30	0	0
Do. Cannanore yard	5	0	0
To rent paid for do.	55	0	0
To postage charges	250	0	0
To coconut plantation maintenance charges	9	2	9
To pay of permanent staff (50 per cent)	681	0	0
To depreciation on value of plant and machinery Rs. 2,681-14-5 + 323-3-6 + 1,449-9-6 = 4,454-11-5 at 10 per cent.	445	7	7
Total ..	1,475	10	4

Receipts.	RS.	A.	P.
By collecting charges	200	12	11
By rent for Cannanore yard due	120	0	0
By miscellaneous receipts— Sale of coconuts, etc., Rs. 384-12-11 .. .. Other receipts Rs. 208-8-6	593	5	5
	914	2	4
By gross profit transferred from Trading account	425	8	4
	1,339	10	8
Net loss ..	135	15	8
Total ..	1,475	10	4

N.B.—No supervision charges have been included in the statement as the Honorary Superintendent has relinquished his control of the station.

Order—No. 2142, Development, dated 17th November 1921.

The Government have read with interest the administration report of the Fisheries Department for the year 1920–21. The Government consider that the results of the year were perhaps not so encouraging as a perusal of the report might suggest. Certain schemes originally included in the departmental programme have proved under present financial conditions too costly to justify pursuing them further and this has been recognized in orders recently passed. In the case of certain other experiments, the principal of which is the cannery, the experience of the year has been the reverse of promising.

2. *Industrial section.—The experimental Cannery, Chaliyam.*—In paragraph 9 of the report the Director refers to the necessity of removing the cannery to a better site. The Government have decided that it is desirable to take this step after a suitable site has been found and as soon as the necessary funds can be allotted.

The cannery is reported to have worked at a small loss of Rs. 1,878-14-11. This figure is arrived at after crediting to the year's revenue two-thirds of the value of unsold products, and this, the Government believe, is a correct method of commercial accounting. They understand, however, that purchasers for these unusually large stocks of canned goods are not yet forthcoming, and that the unsold stock has since increased. Unless a market for this stock develops, it is clear that the actual loss on the year's working will be much greater than that appearing in the report. It also seems likely that these conditions will repeat themselves in the year 1921–22.

The question of this cannery has recently received much attention from the Government. The management appears to have been satisfactory enough so far as its efficiency in small scale production is concerned, but from the financial point of view it cannot be regarded as anything but discouraging. The Government are convinced that if pioneering efforts are to be followed by private enterprise, it is essential to demonstrate not only efficiency of manufacture but the possibility of regular profits. It is hoped that the reconstruction of the cannery on a more suitable site together with more attention to the selling part of the business may demonstrate this possibility. The cannery has been peculiarly affected by the fact that the local demand for its products was largely a war demand, and it was unprepared with any selling agency sufficient to meet changed conditions.

3. *The Tanur Experimental station* also showed a small loss during the year, but this is a minor matter. These experimental stations are not necessarily intended to show a profit

4. *Public fish-curing yards —Paragraph* 15 *of the report.*—The question of the policy to be adopted in respect of the compulsory

introduction in Government yards of the hygenic methods of fish-curing originated by Sir Frederick Nicholson, has also recently received much attention from the Government. Political disturbances in Malabar are however likely to compel the postponement of the wider introduction of this policy at least for some months.

5. *Sea-fishing experiments—(a) With ordinary fishing boats and gear.*—The Government note from paragraph 16 of the report that the experiments known as the inshore fishing experiments in Madras have been of value for scientific purposes. Their main object, however, it is understood, was to demonstrate the possibility of using Malabar canoes and nets on the East Coast near Madras, and the possibility of obtaining larger catches by these methods than do local fishermen through the methods they employ. In this object the experiment has so far been completely unsuccessful. Local fishermen have in fact refused to experiment with these canoes and nets except on condition that they shall be permitted to fish within the Madras harbour, a concession not ordinarily allowed to fishermen. It appears moreover that successful fishing within the harbour would demonstrate nothing of value regarding the utility of the canoes and nets under ordinary conditions.

A similar history has attended the experiment with the Ratnagiri boats known as Machwas on the Malabar coast. This experiment was temporarily discontinued during the year under report, and it has since been decided to give it one year's further trial. The results of these experiments must be deemed to be rather unsatisfactory in that they have not yet succeeded in persuading fishermen on any part of the coast to adopt any change in fishing methods: nor has the department itself been able to demonstrate the fact that larger catches can be secured by any methods that they advocate.

(*b*) *Larger scale experiments.*—To the same general branch of experiment, that of improved methods of sea-fishing, but to a separate section of it, belong projected experiments in what may be termed 'capitalistic' conduct of fishing, i.e., experiments in vessels of such a size that they would be beyond the means of any ordinary fisherman, though in some cases quite possibly within the means of the master-fisherman or a group of master-fishermen. The question has long been debated whether the Madras Government should experiment in this connexion with a steam trawler. It has now definitely been decided not to embark on this experiment, the cost of which would now be very great. The Bombay Government, it is understood, is making such an experiment, the results of which will doubtless shortly be available.

In paragraph 27 of his report the Director refers to a proposed experiment with a motor-driven launch using a Danish seine. The Government have now decided to accept this recommendation and to experiment on these lines.

6. *Pulicat Oyster farm.*—The Government note with satisfaction the improved results from the farm during the season.

7. *Chank fishery.*—The Government are aware that they must expect a much reduced profit on the chank fishery during the current and some succeeding seasons owing to the reduction in the price of chanks which is due to economic causes beyond the Department's control. This particular cause did not apparently operate during the year 1920–21 in which the sale price of chanks to contractors was based on a contract entered into three years previously. The large reduction in profits in the year under report is due to a different reason, viz., the much smaller number of shells fished, caused it is believed by

(*a*) comparative exhaustion of the chank beds and failure to find others equally good, and

(*b*) constant difficulty about obtaining a sufficient number of divers.

The Government have on the recommendation of the Director endeavoured to meet the latter difficulty by raising the remuneration of divers employed on the Tinnevelly coast, which is based on the number of chanks fished. The Director has also promised an investigation into the causes of the fall.

8. *Marine Biologist's section.*—There has been much discussion during the year on the subject of the scale on which this work should be performed, its scientific utility and the probability of co-ordinating it in the near future with any work likely to increase the catches of edible fish or, in other words, likely to result in commercial advantage to the public or to Government. Its scientific utility is not questioned, but the Government have decided after full consideration that the probability of obtaining any commercial results is remote, and for financial reasons they are unable to continue the work on its purely biological side, a matter which belongs more properly to the Zoological Department of the Government of India. The Government have therefore since dispensed with the services of the Marine Biologist on the termination of his two years' agreement, and are continuing only such branches of the department's biological activities as can be performed by a small staff of subordinates under the scientific control of the Director. One of these activities is the supply of zoological specimens for educational purposes to colleges and schools. This work was originated by the present Director when occupying the post of Marine Biologist, and continues to be successfully performed.

9. *Madras Marine Aquarium.*—This institution continues to be popular and profitable. The question of constructing a marine aquarium for purposes of research and education on a much more ambitious scale has long been under the consideration of Government. They have now decided not to proceed with the scheme for the present. Indeed the necessity for such an aquarium is closely

related to the development of biological research discussed in the previous paragraph.

10. *Inland pisciculture.*—The Government agree with the Director that this portion of the department's activities is satisfactory and that it is perhaps the one in which the greatest immediate advance is to be expected. The improvement of breed and quantity of fish in small inland waters presents a problem much easier of solution than the increase of sea catches, and in its nature far less likely to be complicated by the conservatism of the fishing class. It is in fact a question of improving the fish supply while leaving the methods of fishing unaltered, while the problem of sea-fishing is exactly the reverse. The weak point so far in these inland fishing experiments appears to be the difficulty of obtaining an adequate return to the Government for the increased fish supplies made available to the villagers. It is not of course suggested that the whole or the major part of the value of this increased fish supply should return to the Government, but a reasonable percentage of it certainly should do so. Indeed any very large extension of the inland fishing activities is likely to be dependent on the Government income derived from this source. So far, it is believed, villagers or contractors concerned have shown a reluctance to bid for the fishing privileges a much greater sum than they had been accustomed to offer before the tanks were stocked. Some advance is however already apparent in this respect and it is hoped that attendance at sales of the departmental officers recently trained at Ennore will produce a further improvement.

11. *Socio-economic section.*—The Government note that there is a considerable rise in the paid-up share capital of the co-operative societies among fishermen and in the number of fishery village schools controlled by the department. The Training Institute at Calicut continues to do satisfactory work.

(By order of the Government, Ministry of Development)

J. M. Turing,
Secretary to Government.

Report No. 2 of 1922.

NOTES ON THE FAUNA AND FISHING INDUSTRIES OF THE LACCADIVE ISLANDS

BY

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WITH AN INTRODUCTORY NOTE BY THE DIRECTOR.

INTRODUCTORY NOTE.

This report consists of the more useful of the field notes recorded by Mr. Ramaswami Ayyangar during a short visit to the islands in 1920. Though necessarily fragmentary, they have considerable value both in themselves and because they fill several lacunæ in the Report on a similar cruise which I made in 1908 *(Madras Fisheries Bulletin No. 4)*; they add materially to our knowledge of the fishing industries of the islands. It is obvious, however, that before any scheme for the improvement of existing methods or for the introduction of new ones is possible, much more intimate knowledge is requisite. Instead of a hurried cruise through the islands in company with the revenue inspection staff, at least a full month's investigation should be devoted to each island if the fishing potentialities are to be ascertained satisfactorily and adequately; enough has now been learned to confirm my first impression that the waters and shores of the islands have considerable commercial possibilities. Left to themselves, no improvements in methods and no extension of fishing operations can be expected from the Laccadive fisher-folk. Although conservative after the manner of their kind, these islanders compare favourably with the mainlanders;

they seem more willing to accept advice and to try experiments, but it is useless to attempt or expect anything if demonstration and material help do not accompany advice. As in all pioneer fishery work, a thorough preliminary investigation is necessary. We want definite and detailed information on the seasonal abundance of the food fishes frequenting the vicinity of the islands; we must ascertain whether the bonito—most valuable of pelagic fishes—is found in large shoals and whether suitable live bait can be found in the island lagoons; we must try whether the Minikoi and Japanese method of capturing them is suitable for local conditions or whether drift-netting may not be preferable. We have to ascertain whether the particular species of flying-fish which, *in the breeding season*, furnishes an extensive and profitable fishing to the Coromandel fishermen, occurs in the Laccadive sea, and if so, when the breeding season is and if these fishes can then be caught by the same ingenious and simple plan as is practised on the East Coast at that particular time. The potentialities of the bêche de-mer fishery also require careful investigation, particularly on the outlying uninhabited reefs, several of which are of very great extent, and consequent promise. It is notable that the small bêche-de-mer industry that existed in Kiltan at the time of my visit in 1908, has died out and is now but a memory. I feel sure that if the islanders be taught improved methods of curing, such as this department has introduced into the Palk Bay bêche-de-mer industry, and if arrangements be made either to buy their produce at a rate that would yield them a fair profit or, alternatively, to arrange to sell it for them on a commission basis, quite an extensive industry might result. Similarly, the export trade in cured fish would expand greatly if encouragement be afforded the islanders to pay greater attention to this trade and if direction in methods and cheap salt for curing be provided. Salt curing is practically unknown

in the islands, presumably because the cost of bazaar salt is considered prohibitive. (No public fish-curing yards where duty-free salt is supplied have as yet been opened in the islands.)

The main conclusions we come to, are that much more detailed information is necessary before concrete proposals for fishery development are possible and that the introduction of improved methods will be valueless unless means be taken to obtain fair market rates for the produce. in similar way to that adopted in respect of the coir production of the islands. Without help given in the marketing of their produce, the islanders will inevitably fall a prey to unscrupulous traders with the result that the unremunerative returns will cause discouragement and a cessation of further effort. A patriarchal treatment of the islanders is necessary till they become more worldly wise.

It is notable that neither long-lining nor drift-netting is practised in the islands. The value of these methods therefore should receive careful attention in any future efforts towards fishery development.

Mr. Ramaswami Ayyangar was successful in finding young pearl oysters alive in the islands ; I doubt greatly if they occur in commercial quantities in any locality ; if they do, it will be in the lagoons of the great uninhabited pārs. As I have pointed out elsewhere, these pārs are veritable *terræ incognitæ* ; they are never visited by the revenue authorities, and no zoological or fishery examination has ever been made of their potentialities. We know only that the island fishermen periodically visit them and bring back good catches of fish. An early investigation should be included in our programme for the development of local fisheries.

The mosquito plague in Minikoi is referred to This is notorious and changes what appears to be an earthly paradise into a place of the utmost discomfort, to say nothing of disease.

I may usefully recall the fact that the member of the Cambridge Zoological expedition to the Maldives under Professor Stanley Gardiner, who was left on Minikoi, contracted malaria and suffered so severely that he had to be invalided home. In any scheme for the development of the island that "Fisheries" may participate in, the possibility of adequately combating this scourge by means of the introduction and breeding of larvicidal fishes in the wells and water pools of the island should be given careful attention and thorough investigation.

3rd November 1921. JAMES HORNELL.

THE FAUNA AND FISHING INDUSTRIES OF THE LACCADIVES.

In September 1920 at the suggestion of Mr. A. Y. G. Campbell, the Director of Industries (then in charge of the Fisheries Department), proposals were made for the Marine Biologist to accompany an inspection party to the Laccadive Islands with a view to gain further knowledge of the marine fauna and to make a general collection of specimens. Subsequently it was decided that only one of this section's staff need undertake the trip, owing to want of room in the inspection steamer. It was eventually arranged that the R.I.M.S. *Minto* should leave Mangalore about the middle of November with Mr. R. H. Ellis, I.C.S., the officer in charge of the inspection party, and his staff, and that I should accompany them.

The party left Mangalore as arranged at noon of the 18th. After visiting all the islands we returned to Calicut on 24th December having thus spent 38 days in all upon the inspection.

The weather on the outward voyage was fine and we sighted the first island Amini, of the Amindivi group attached to South Kanara district for administrative purposes, at noon the next day (19th November) and landed at 4 p.m. amidst light showers of rain, an unusual happening at such a time of the year.

AMINI is the chief of the Amindivi group and the head-quarters of the Monigar; it possesses a dispensary with a small meteorological station, in charge of an Assistant Surgeon, and a Government elementary school. The other three inhabited islands attached to it for administrative purposes are Kadamat (8 miles north and just seen from the beach), Kiltan and Chetlat. Amini is about 620 acres in extent. The soil is fertile, coconut palms growing luxuriantly. The people, who were enumerated for the 1921 decennial census, numbered 2,152; they appear to be in affluent circumstances. Of late the island has been divided into factions partly due to petty local jealousies and partly to the upheaval of the lower classes, such as Melacheris, etc.—who are toddy drawers, ordinary labourers, etc., by profession—caused by the treatment accorded to them by their caste superiors (Koyas, etc.).

On the 20th and 21st plankton collections were made. On the first of these days a trial was made with the help of a diver of the island to get specimens from the bottom. The man was able to bring only a few broken pieces of Madrepora. From the way in which the diving was done I came to the conclusion that no good results could be hoped from this. No stone or other appliance is used for help as is the case with Tuticorin divers. The man dived into the water head first. Nor was he able to keep to the bottom for more than a few seconds.

A big Bat Ray (*Dicerobatis*) was brought ashore this day. It measured 15 feet across the disc and 11 feet long ($6\frac{1}{2}$ feet disc and $4\frac{1}{2}$ tail); a local fisherman told me it would weigh approximately 20 *thulams* (560 lb.). Curiously enough the stomach contained nothing, a fact which the men say is quite common. A good number of sucker fishes (*Echeneis*, two species) were found sheltering in the mouth of the big beast, varying from $1\frac{1}{2}$ to 14 inches in length. Parasites both from the œsophagus and from the mouth, were taken and preserved.

At the request of the Inspecting Officer earthworms were collected from this island and later also from Agatti, Kavarti, Kalpeni and Androth. These were sent to Dr. Stephenson, late Principal, Government College, Lahore. His remarks on the collection are that "They are all, except two specimens, *Megascolex mauritii*, a widely distributed peregrine form. The other two are *Megascolex konkanensis*, a South Indian species. The collection illustrates the uniformity and borrowed character of the earthworm fauna of these and other similar islands."

On the 22nd the counting of the people of the island took place and so no fishing boats went out. The programme for the 23rd was to go to Kadamat in the morning and return in the evening, but rough sea prevented our going. There was slight rain between 10 a.m. and 2 p.m. A fairly low tide occurred in the afternoon permitting examination of the exposed western reefs.

The next morning (24th), after another postponement of the visit to Kadamat owing to adverse wind and sea, was spent in inquiring about nets and other fishing methods and fish and turtle oil preparation. The afternoon was spent in collecting on the reefs on the west side. Among other animals, three young living pearl oysters were found. This confirmed the remarks about the possible existence of these referred to in Mr. Hornell's report printed in the

Madras Fisheries Bulletin No. 4 (p. 116). The lack of skill in the local divers taken together with the condition of the sea-bottom as described in the above report, made it impossible to continue the search for adults.

Low tides are taken advantage of by the women and boys and girls of the island to collect Octopus (*Appalu* in vernacular) from the reefs. With two short sticks about three-quarters of a yard long (iron rods thick enough not to bend are also used) in their hands, the people wade through knee-deep water, straining their eyes to find out the crevices among the corals where the animals shelter and from which at times they thrust out one of their arms in search of a probable prey. Immediately on locating the animal the sharp point of one of the sticks is thrust into the animal and with the help of the other the victim is brought out of its retreat. They are made into curry with the usual spices or into soups.

Small fish are also caught from among the clumps of the big corals by means of a small net called Muduvalai.

KADAMAT.—On the 25th morning we left Amini in a country boat and landed at the southern extremity of Kadamat island at 10 a.m. This island is long and the largest in the whole archipelago. The soil is fertile and the jungle-like growth of trees and shrubs in the south is noteworthy, while the northern end of the island is a waste of coarse tall grass, scrub jungle and screw pine, though in recent years coconut plantations have been begun in earnest here, and also in the new accretions at the southern end. Though Alcock who visited the island in 1891 makes mention of " lime trees growing and bearing fruit such as one seldom sees in India," except for a scraggy tree with fast dying branches I was not able to find any lime trees. The men are stronger than in Amini and the island appears to have been colonized by, and worked for, the landlords of that island. The charge that " the islanders were sinfully neglectful of their opportunities " can no longer be brought against them, yet the people appear poor (as Mr. A. O. Hume remarked) as a result " of an oppressive influence exercised by the capitalists of the adjacent small, but thickly populated, island of Amini." The area of the island is 750 acres and the population 577 according to the enumeration made while we camped there. During my stay nearly three-fourths of the eastern side of the reef was examined. The corals are in a living condition and luxuriantly growing while the interspaces afford protection and breeding ground for many

molluscs and holothurians. A good collection was made and an interesting find at the southern end was dead young pearl oysters, thus confirming beyond doubt that mature ones must occur in the waters around this island.

Better attention is paid here to fishing than at Amini. I found fish being dried in the sun, hung on ropes. They are not treated with salt in any way but merely washed in sea water with two to three scores along the sides to allow rapid drying.

Owing to uncertain weather conditions the return to Amini was postponed to next morning (26th). We arrived at Amini at 10 a.m. and immediately proceeded by R.I.M.S. *Minto* to Chetlat.

CHETLAT.—The next morning I examined the reef at the north-east of this island. The whole beach at this end is covered with a kind of calcareous algæ (*Lithothamnion* sp.) which is mentioned by Professor Stanley Gardiner as one of the active agencies in the formation of coral reefs.

Beyond collecting shells washed ashore and making inquiries regarding the nets, etc., in use and about the abundance of Trochus and Turbo shells said to be suitable for making buttons, much work could not be done here. In the course of the day a *Kandali-valai* was dragged in the lagoon and the catches examined. The haul contained 3 spine-tails (*Acanthurus*), 4 *Caranx*, 15 matti (*Lutjanus*), 1 big *Balistes* and a spiny puffer fish (*Diodon*), not edible.

In my opinion the general fishing capacity of the people of this island is low owing mainly to their poverty-stricken condition. The main occupation of the islanders is coir-making; the product is taken to the mainland to be exchanged for rice, but the people express as a grievance that their quota of coir supply is fixed too high, leaving little time for other activities. There is scarcity of husks for fibre as a consequence of the poor yield of nuts of the island trees and a proposal was made by them to the officer to grant them a licence to remove husks from Bangaram. Hence the men are taking to other occupations such as cutting and carrying fuel to Mangalore, Calicut, etc., from other islands. One such batch of men was seen at Kalpitti islet of the Agatti, adding to their thin rice gruel (*kanji*) the baked flesh of a Pterocera.

Pterocera chiragra and *P. lambis* are found in abundance around this island; these and other big Gastropods (*Conus*, etc.) are baked in the fire and eaten by the people. Large quantities of the shells of *Mesodesma glabrata* are found as kitchen middens in this and

other islands and the "giant clam" (*Tridacna*) gives a substantial dish at times. The islanders are poor when compared with the people of the other islands and the men and women are on short commons at times owing to the irregular supply of rice from the mainland and partly to the difficulty of finding profitable outlet for their produce. The population is 761 and the area is 255 acres.

KILTAN.—At 9-30 in the night of the 27th November we left this place and reached Kiltan the next morning. The various forms of fishing apparatus in use were inspected and notes taken of the methods of using them.

The people of this island number 675 and the area about 400 acres. The soil is generally fertile and some enterprising men have grown tamarind and other trees; while one garden showed cholam bearing pretty bunches of grain. The northern end of the island is a jungle of tall spear grass which, I am told, is a good substitute for hay. The guide who accompanied me showed with pride his small garden where chillies were growing as shrubs 6 to 8 feet high, together with cucumbers bearing fine fruits. Though the inbabitants were not found in "much distress and anxiety" as stated by Major Alcock in 1891, when 8,000 of their coconut trees were destroyed by a storm (the effect of this storm is still seen in many trees growing in a slanting posture) and the long expected consignment of rice from the mainland was long overdue, yet the people look poor and a feeling of helplessness prevails ; they say they are starving though to me they appeared not so badly off as the Chetlat people. At one house visited, the people were having as a meal a preparation made by boiling a landweed with *mira*, the local name for sweet coconut toddy.

Fishing operations are a bit brisker here than at Chetlat. Fish was drying on the beach. Small fish are scored through to allow quick drying. Big sharks and rays (*Kōttār*) are cut in pieces and hung on ropes to dry without being treated in any way, while *kudiraimin* and *olaimin* (*Histiophorus*) are made into "mas." This is done by cutting the big fish into chunks of about three inches square, which are boiled in sea water for ten minutes and then put in the sun to dry. This they expect to keep good for six months and more. Shark fins are dried and exported to the mainland at a price of Rs. 20 per *thulam*. It was in this island that I heard a pearl had been found, some three or four years ago, in a *Tridacna* and sold for Rs. 20. Regarding *kōkā* (bêche-de-mer) curing, except for

the statement that it was once practised no traces of the industry were found. The failure is attributed to poor prices for the manufactured product.

As our stay was very short, detailed inquiry and investigation was not possible. We left the next morning at 6-15 a.m. and after putting ashore at Amini the Monigar and the Assistant Surgeon of that place, we proceeded towards Agatti (the westernmost of the inhabited islands of the group), which we reached at 5 p.m.

At AGATTI we camped from 30th November to 7th December, the last three days spent in the vain hope of sighting the R.I.M.S. *Minto* and proceeding by it to the next island, Kavarti.

The lagoon of this island is ideally situated, being of large extent with depths of three to four fathoms which greatly facilitate collection of zoological specimens. Opportunity was also afforded while here of making short visits to the outlying uninhabited islets of Kalpitti and the Bangaram series. Detailed inquiries were made as to fishing apparatus and methods, and a good find of young pearl oysters, together with a collection of various shells, was obtained. The island is one and one-eighth square mile in area and has a population of 1,084. It is tolerably fertile and the people are well-to-do; there are signs of comparative happiness and comfort. It is a "fine large populous island standing at the southern end of an atoll which also rises into two small islets at two points further northwards and is thickly covered with coconut palms beneath which the thatched coral-stone houses of the inhabitants are picturesquely scattered among lime-bushes on which fine fruits are hanging." (Alcock: *A Naturalist in Indian Seas.*)

On the morning of the 30th November, the north beach of the island was examined and notes taken of the fish traps and other kinds of fishing appliances in use.

December 1st.—This morning I took a boat and went to the small uninhabited islet (*Kalpitti*) at the south end of the reef separated from the main island by a channel from one to two fathoms deep at high water and 200 to 300 yards wide.

My chief object was to search for Amphioxus and Balanoglossus by sieving the sand in the separating channel. The first sieve revealed a few dead young pearl oyster shells; on this a close search was made among the Madrepore corals and I was able to detect a number of live young pearl oysters adhering in bunches of

from four to six. It appears to me that the larvæ before they come to the sedentary stage are driven by the force of the current from the east to the west through the dividing channel and attach themselves to corals, etc. The difficulty of finding proper divers in the island made it impossible to verify the existence of mature oysters in the deeper waters of the vicinity.

This small islet is of little interest save for the shells to be collected around it during low tides. The few coco-palms standing there bore no fruit ; they are either eaten by rats which infest the island or by the visitors who resort to it for fuel cutting and for fishing. Small trees abound and every tree and bush are overgrown and hidden by the thick covering of a spreading creeper making them impenetrable and giving refuge to myriads of eye-flies. The corals and rocks along the water's edge are worn into sharp edges and points and the beach is strewn with plenty of dead branching Madrepora. Natica and a knobbed Purpura are present in large numbers.

On the *2nd December* a plankton collection was made in the sea outside the reef and at noon the contents of a haul of Kandalivalai drawn in the lagoon were examined. There were 45 fish in all, of which 21 were *Caranx*, 15 *Lutjanus*, 4 *Balistes* and 3 big *Ostracions* with a stray *Tetrodon* and *Naseus unicornis*. The stomach contents of *Caranx*, *Lutjanus* and *Naseus* were examined. The last appears to be of vegetarian habit as the stomach contained a large amount of seaweed in various stages of digestion.

The next day was spent in going over the reefs on the eastern side of the island and in examining the sandy patches therein for Amphioxus and Balanoglossus. But none were found. In the evening the catches of a boat practising "*Chūttu*" method of fish catching in the lagoon, were examined. Sphyræna, Belone and Hemirhamphus are the fish caught principally by this method.

On the 4th December the three uninhabited islands of *Bangaram*, *Tinnakara* and *Parali* (7 miles north of Agatti) were visited. The first lies in a north to south direction, the other two east and west. The first is separated by a wider and somewhat deeper channel passable only by small fishing boats and at low tide from 3 to 4 fathoms deep. Big masses of Porites are seen in patches about 15 to 30 yards diameter trying to rear their heads to water level. In recent years land has formed on all sides except the south and the whole reef at low water appears to be one

continuous stretch. A large sand bank with about half a foot to two feet of water during low tides, is forming to the west and north sides of Bangaram and also of other islets to the east, providing a fine breeding ground for young turtles, while all the sand heaps of the three islets are full of pits, small and big, excavated by turtles wherein to lay their eggs. The reason for these three islets being uninhabited is said to be due to want of good drinking water but the water at Tinnakara tastes well. The space between Tinnakara and Parali (which again is in two fragments) is shallow during low tides and can be waded through easily.

Boatmen and fishermen resort to these islands for fishing and coconut collection and they say that "Muthuchippi" (pearl oysters) can be had in good numbers at Bangaram ; but to my request they were not able to bring anything and the description given by them leaves me to doubt whether the "chippi" they refer to is the real pearl oyster, for subsequently they showed me a valve of a big Pinna as a sample of Muthuchippi. After inspecting Parali, Tinnakara and Bangaram we left at 3 p.m. and returned to Agatti with a fine breeze at 5-30 p.m.

Abundance of fish are found in the waters around these islets for in about half an hour the boatmen were able to capture by the cast net upwards of 30 red mullets or goatfish (*Upenoides* sp.); the vast sandy stretches abound here in sipunculid worms (*Sipunculus indicus*), 15 to 20 inches long, and ½ to ¾ inch thick which are much prized as bait in angling. The method of collecting these latter is worthy of note. During low tides when the surface sand is exposed the bait men search for the holes wherein these worms live. A short stick (generally made of the midrib of coconut leaf), two feet long, is pushed into the holes to such a distance (say ¾ to 1 foot) that it enters the body of the animal for about half its length, thus preventing the worm from burrowing deeper. Quickly the sand round about is scooped out by hand and the stick and the animal pulled out, the intestine being removed by pressing hard and then cut into pieces for use as bait. A trial sieving of the sands at the north-west corner of Bangaram brought only a few small worms, but no Amphioxus, for which I tried particularly.

Fragments of pumice stone are strewn all along the beach at high water mark both at these islands and at Agatti. A few of these and also specimens of *Ithala* (*Dioscorea oppositifolia*) with root and plant were preserved. The latter plant grows wild at Bangaram

and out of the root a coarse kind of sago-like preparation is made which is largely eaten by the island people.

The bulb, after being cleaned of sand and mud and the removal of the small roots sticking thereto, is cut into strips and washed in fresh water, changing the water half a dozen times, to get rid of the mucus and also part of the bitterness. Thereafter the strips are dried in the sun and powdered well into coarse and nice grains. Again it is passed through fresh water to remove completely the bitterness which otherwise is left in the product. The powder is used in the preparation of *kanji* and also generally mixed with rice flour, boiled *mira* (sweet coconut toddy) and coconut scrapings to be made into round balls called in vernacular "*pindi*." This is much valued as a sweet eatable by the island people and is much sought after by the ordinary people coming from the mainland.

On the 5th December, a plankton collection was made opposite of the Amin's cutcherry; while at this work I saw a shoal of fish followed by seagulls; the boatmen said they were "Mas-min" (Bonito). In the afternoon inquiries were made regarding fishing appliances and also the so-called "pearls" from Modiola. The steamer *Minto* did not arrive to take the party to the next island of Kavarti; hence a country boat was engaged and we left at midnight on the 7th, arriving at Kavarti at 10-30 a.m. the next day.

The island of KAVARTI (area one and one-third square mile; population 1,461) is similar in shape and appearance to most of the other islands of the group and the people appear to be living comfortably and in better sanitary conditions. The houses are encircled by kadjan fencing and the space thus enclosed kept clean and neat. Pitti sandbank (15 miles north-west) and Suheli reef (35 miles south-west) are attached to this island.

On the afternoon of the 8th December the reef at the entrance to the lagoon was examined. The coral growth was found to be in dead condition, but the very first examination among the branches of Madrepore corals revealed young living pearl oysters, again confirming the view that pearl oysters are available in these waters. The people here also seem not to recognize the real pearl oyster and the description of their pearl oyster refer to black Pinna shell which is said to be found in plenty at Suheli. A collection of corals was made and two specimens of Tridacna were obtained alive. The next four days were occupied in collecting, the most notable specimens being big hermit crabs living in

empty coconuts still enveloped in their husk; this considerable weight they are able to drag behind them without apparent effort.

Leaving Kavarti on the night of the 12th, we reached MINIKOI at noon the next day. This is the southernmost of the islands under the administrative control of the Collector of Malabar. As is apparent at sight the people in their language, dress, habits, customs, communal organization and fishing methods are entirely different from those of the Laccadive Islands.

Owing to the notorious mosquito trouble of the island, it was proposed to stop only one night at this island. Owing to language difficulty—all available interpreters being occupied with census duties—I was not able to make extensive inquiry, beyond collecting shells. This was of less moment seeing that Prof. Stanley Gardiner has already carried on investigations during a lengthy stay in this island. The two most interesting items in the collection were *Magilus*, a peculiar shell growing embedded in corals, and a sea-worn chank. As usual with other islands, the fishermen did not go out to sea on account of the inspecting officer's visit and my attempts to get specimens of the small fish kept for bait in bonito fishing were not successful. The description of bonito catching and curing adopted by the islanders is given in detail in Mr. Ellis' report on his 1908 inspection of these islands.

From Minikoi we proceeded to KALPENI where we stayed till the 19th December. This island appears at a distance as four separate islets which consist of the island proper and the detached islets of Cheriyam, Tilakam and Pitti. It is one square mile in area and has a population of 1,375 according to the recent enumeration. The main island is long and narrow and about halfway towards its northern end great boulders of coral interpersed with sand and debris make their appearance. In this island, as also in Androth, excavations have been made and regular plots formed for cultivation purposes in which paddy, sweet potatoes, etc., are raised. The lagoon, though large, is very shallow and this fact makes me to think that eventually a very big island will be formed with the present land as its nucleus at the southern end. Till then the northern half of the island and the lagoon and the small islets towards the south and north should prove admirable collecting ground for zoological specimens and also a very suitable place for studying the general phenomena of the growth and formation of coral islands.

While here I visited one evening the Tilakam and Pitti islets to the south; and after a preliminary survey of the island, spent a morning and an evening in going through newly formed and forming portions towards the north with a view to form an idea of the locality and also to reach the northernmost bit of Cheriyam. A good collection of shells was made and small fish caught by casting nets, were preserved. A big Stegostoma was found washed ashore, thrown away by fishermen as people say they are not eaten. In this island also young dead pearl oysters were found. A plankton collection was made and other points of interest noted. As a result of this short visit I came to the conclusion that in case this department intends carrying on a detailed study of these coral islands, this island is best suited for the purpose.

Leaving Kalpeni on the 19th night we landed at ANDROTH at noon on the 20th. This island is the largest of the group measuring one and two-thirds square mile in extent with a population of 2,492 (December 1920). In general appearance, it is like Amini--compact in form and running east and west unlike the other islands of the group which lie in a north to south direction, and presenting a long appearance. There is practically no lagoon and a fringing reef extends all round to a width of from 100 to 200 yards, an area which is exposed during low tides.

The people are prosperous and progressive and they look healthy and dress in a well-to-do style. Being nearer to the mainland they have largely copied modern methods of Indian life. As usual in the island life of this locality, this island is divided into two factions, the Government Amin with one or two Karanavans on one side and all the other Karanavans on the other. The dethroning (according to the conception of the island people) of the Amin from his post, a favourite event which his opponents enjoy, is the result of such factions, and in this place the Amin was suspended for misconduct.

We stayed till the 23rd. Two days were spent in collecting and examining the reefs. Plankton collections were also made. Plenty of Modiola in matted masses occupy the floor of the exposed reef. A solitary Echiuroid was picked up. Turbellarian worms were found in plenty in the reefs below coral stones as also Holothurians of some half a dozen species. The fishing methods in use were inquired into. Regarding the method for capturing

flying-fish advised to the islanders by Mr. Hornell (vide *Madras Fisheries Bulletin* No. 4, page 122), the men told me that they experimented with the method on one or two occasions, but it was not a success. It may be that they tried this at the wrong season of the year.*

The bêche-de-mer industry which was a success for some time in this island has been abandoned, the reason being that an epidemic of cholera of a few years ago was attributed to the insanitary condition in which the curer kept his yard at that time. The usual rat hunt which is practised in the islands during the Inspecting officer's stay was carried out here also and specimens preserved. These and the Kavarti ones were sent to the Bombay Natural History Society on instructions from Mr. Ellis. They are stated to be all varieties of the common rat (*Rattus rufescens*) which is occasionally a serious pest. They play such havoc that at times in certain islands no coconut is left for plucking. Sometimes a stray shrew (*Pachyura* sp.) is met with during the "hunt." Earthworms also were obtained and preserved.

We left the island—the last of the group—at 4 p.m., and sighted Calicut port at 9-30 a.m. the next day, landing at 1 p.m.

Boats.—Apart from the big cargo boats (called *Kundara*) used for carrying the island products such as coir, copra, etc., to the ports on the mainland, usually Mangalore, Calicut and Tellicherry, the general fishing boats may be classified into three kinds according to sizes:—

	No. I.	No. II.	No. III.
Length...	18 ft.	24 ft.	32 ft.
Breadth	6 ft.	8 ft.	9 ft.
Number of partitions made to allow rowers to sit ...	2	3	4
Crew generally required ...	4	6	8
Approximate cost	Rs. 40	Rs. 60	Rs. 80—100

The wood used in the construction of these is from the island trees, e.g., Puvarasu, Punna and Chirani. The fishermen themselves are able and fine carpenters and the boats are of the best workmanship under the circumstances. They possess sails; but at times, the work of rowing, in order to reach and return from, the

* This method is successful only during the breeding season and in respect of one species only.—J.H.

fishing banks, involves so much labour to the crew that they say they are almost tired when they arrive at the banks. If our department undertakes to experiment and devise a small marine motor of moderate cost for these small boats, to occupy not more than one-fourth of the space of the boat, it would be of immense help to the men in their fishing work, in making larger and more remunerative catches.

The appearance, size and construction of the Minikoi boats are entirely different and as the men of that island are already having a prosperous and progressive fishing nothing need be done at present for them.*

Besides the ordinary boats for fishing there is a peculiar substitute for it used in large numbers by the islanders of Kavarti. It goes by the name *Tarappam* (Tamil equivalent, *Teppam*) called also by some *Sangādam*. Some 10 to 16 (generally 12) pieces of the straight light Patti wood (resembling bamboo poles in their straightness and lightness) are placed side by side and tied together by means of cross pieces of the same wood (one above and the other below). In the middle a small additional piece of wood is also tied, on which the bag to contain the catches is kept. At the four corners the outside poles project about a foot for facility of carrying the tarappam to shore and back. Patti wood is found in plenty in Kavarti Island, hence the large numbers use in there. This raft is used in the lagoon both during day and night and manned by four to eight men with one rudderman and a harpooner in addition. Occasionally they go outside the lagoon to fish on the outer margin of the reef at a depth of 3 to 5 fathoms. One of them measured 18 feet long by 4½ feet wide, divided into six sections.

Fishing appliances.—The various appliances used for fishing in all these islands are more or less the same. They may be classified under the following four heads :—

(*a*) Nets—worked in the lagoons only ;

(*b*) Traps—also worked in the lagoons only ;

(*c*) Harpooning—practised both in the lagoon and in the sea, with or without hook and line ; and

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* These boats are described in "The Origin and Ethnological Significance of Indian Boat Designs" by J. Hornell, in *Memoirs of the Asiatic Society of Bengal*, Vol. VII, No. 3, 1920.

(*d*) Hook and line—either alone or combined with spearing. Practised in the deeper waters of the lagoon but mostly and very skilfully in the sea along with harpooning.

Nets.—The names in vernacular of the nets in use are—

Kandalivalai.	Vichuvalai.
Adivalai.	Nuluvalai.
Koruvalai.	Muduvalai.

A description of Kandalivalai, Adivalai, Koruvalai and Vichuvalai is given by Mr. Hornell in *Madras Fisheries Bulletin* No. 4, pages 111–12, 119–20, and, except recording more measurements of these nets in the various islands, nothing particular can be added to the information already in print. The average measurement of a Kandalivalai is from 120 to 200 feet long and 8 to 12 feet wide according to the depth of the home lagoon; the price may be put, according to the fishermen's quotation, at Rs. 50 to Rs. 60.

Nuluvalai.—A net of this name was shown to me in Kavarti. It is exactly like the Kandalivalai. It is nine fathoms long with a smaller mesh (½″) and with small coral stone weights attached, 5 per fathom. This is used solely for catching small fish in the lagoons.

Muduvalai.—This is a small net, shown in Kiltan Island, conical in shape and measuring 15 feet in circumference at the bottom, 6 feet deep and 3 feet wide at the short end. During low tides it is dragged in such a way that the net is brought over the small boulders of rocks within the lagoon. The small fish sheltering among the clumps of coral stones are thus captured.

Traps.—A photograph of one with a short description is given in the *Madras Fisheries Bulletin* No. 4, page 113. They are heart-shaped in form and their sizes vary from 5 to 10 feet long, 3 to 6 feet wide and 2 to 4 feet high. At Kavarti larger and capacious ones are found and are very strong in construction. The number in use is larger in some islands (e.g., Chetlat and Kavarti) probably on account of the difficulty of going to sea. These traps are laid close to the place where the surf breaks on the reefs. No bait is used. They are in use generally between June and December (often only up to October, as I noticed many of them not in use and stored on the beach) and various kinds of fish are caught including dogfishes.

Harpooning.—The art of capturing fish by this means is very skilfully practised in all the islands. The harpoon poles are made

of coconut wood by the fishermen locally and they are very nicely fashioned. They are generally 12 feet long and 1½ to 2 inches thick. The harpoon head is either single for catching ordinary fish or has triple (big) prongs, used when spearing big fishes, particularly ayakura and kudiraimin, etc.

The iron head (*uli*) is attached loosely by means of a socket to the end of the pole (*kalavu*) in such a way that, as soon it is thrust into a fish, the head, to which a long rope of 30 to 50 fathoms is tied, readily becomes detached. When the animal is exhausted it is hauled up alongside and lifted into the boat—a short gaff being used for the purpose.

Another form of spearing often practised in the lagoons in all the islands during dark nights is termed in the vernacular "*chūttu*." In the dusk just after sunset, the fishermen set out in a boat provided with a number of dried coconut leaves made into long bundles and several of the peculiar spearing poles; the name of the spear is "*chilla*." The head is made of wooden spikes of two sizes and placed concentrically in two slightly diverging circles. The spikes of the outer row are thicker; those of the inner, thinner and a little shorter; both of them are very firmly fixed by being tied on with coir twine. In addition to its use in the lagoon for "*chūttu*" fishing, it is also used in the open sea for capturing flying-fish. In the lagoon elongated fishes are those most frequently caught, e.g., Sphyraena, Belone, Hemirhamphus, etc.

Line fishing.—This is the most important method of fishing practised in the islands, and, combined with spearing, gives the men of the island great sport at times. The pleasure which they exhibit when they catch specially big fishes is notable. The hooks generally used are of three to four sizes, ranging from small steel hooks of European manufacture to those measuring 8 inches long and ¼ to ½ inch thick of local make. That used when fishing for sharks is secured by iron or brass chain, about a yard long, to prevent the line being bitten through. The medium and small sized ones are tied to the rope in the usual manner. That kept specially for catching ayakura and kudiraimin is a triple pointed one of local make. The line is ordinarily 30 to 50 fathoms long. About 4 to 5 such coils are carried in every boat together with two or three harpoons of both forms. The harpoon head used for catching turtles is armed with a single barb.

Neither nets nor lines are barked or coloured. The white sand of the bottom suits the natural colour of the cotton nets so well that the men state that barking and the consequent colouring of these frighten and disperse the fish. There are plenty of mangrove bushes on the islands, the bark of which could be utilized for the purpose. Under the peculiar conditions prevailing in the island waters, it is probably better not to bark the nets in spite of the disadvantage of the more rapid deterioration of unbarked nets.

Their lines are made of cotton thread, 20 to 40 counts, purchased at Cannanore, Tellicherry, Calicut, Mangalore, etc. Aloes (a short leafed variety) abound in all the islands; the fishermen were shown how to extract fibre therefrom and demonstration made of the strength of a rope made of it. But they showed no interest and prefer to buy their thread ready prepared.

Bait.—The bait generally used is coconut kernel cut into small pieces; small fish and the flesh of hermit crabs add to the supply in some islands. Another important bait is the flying-fish and when the men go to the fishing banks, the first few minutes are spent in catching these for bait purposes. But when they are not available, the Poë-min (wooden "false fish") is used with great success as a substitute. The making of the wooden patterns and the practice of this method of fishing, are pleasures much appreciated both by the fishermen and visitors. A general description of these poë-mins is given at page 114 of the *Madras Fisheries Bullètin* No. 4, as also photographs showing its actual operation. There are as many patterns of these poëmins in every island as there are separate families of fishermen, and they say they are able to claim ownership to missing ones according to the small differences introduced in the ornamentation of these wooden dummies.

Fish curing.—As stated already no special method of treatment to preserve them for any lengthy period is usually followed, except that of "*mas*" prepared on all islands; in Minikoi, both the fish treated and the nature of the product are different and form more or less a separate commercial brand. Generally fish are eaten fresh, but whenever catches more than daily requirements are brought in, if they are small ones they are given two or three scorings on the sides and hung up in the sun to dry. With big fish such as Ayakura (Seer, *Cybium*), olaimin (*Histiophorus*), kudiraimin and big *Lethrinus* and *Serranus*,—they prepare "mas" by the following

process. After removing the head and guts they are cut into pieces of 1½ to 3 inches square, washed in freshwater, boiled for about 5 to 10 minutes in a mixture of half fresh and half sea water, drained and taken to the smoking pits. These are more or less small square excavations in the ground, generally opposite to their living houses, 2 to 3 feet long, 1½ to 2 feet wide and a foot to a foot and a half in depth, and covered by a sort of trellis work of coconut leaf midribs. On this trellis the boiled pieces of flesh are arranged; a slow smoking fire is lighted beneath in the pit and kept going for two to three hours till the flesh turns red (or black in certain islands). Then they are dried in the sun for 3 to 4 days until quite hard. This product is said to keep good for six months and even one year, of course with an occasional drying in the sun. At present the product is cured for home consumption only.

Bonito or Mas-min.—It was at Agatti that I saw a shoal of these fish and when I told the Inspecting officer (Mr. Ellis) of this fact he asked me to inquire into the present condition, difficulties and possibilities of introducing the well-known "mas" fishery of Minikoi Island into the other islands also. It was suggested that the difficulty at present expressed by the islanders in not launching forth into this special fishery, is partly due to paucity of "mas" fish, partly to ignorance of the methods of capturing them. Fishermen generally say that "mas" fish is available in their seas also. But there are a few who doubt its existence in such numbers as to create a profitable industry, and hence a disinclination to go out prospecting for shoals of these fishes. Granting that the fish are available, and the men take the trouble and incur expenses to undergo a training in the methods followed in Minikoi, there may probably be a bait difficulty. From the description given in Mr. Ellis' report the keeping of the "live fish" bait is an all-important condition for the success of the fishery. The fishermen of the other islands doubt the availability in their lagoons of small fish required for bait in sufficiently large numbers. Lastly, the men doubt whether the Minikoi fishermen can be induced and hired to teach the other islanders the method of capturing, and, even then, whether they will disclose the secrets of their methods. As an instance, the men point out the failure of the efforts of a former Amin of Androth who, a few years ago, built, at a cost of Rs. 500 to Rs. 1,000, a boat of the pattern of Minikoi but did

not succeed in doing anything practical. The general opinion, however, of the island people is that the fish are available in good numbers, and that it is only their ignorance of the methods of capturing (curing is not considered difficult) which stands in the way of the industry being taken up by them.

In order to know whether any Minikoi men will be willing to teach the fishermen of the other islands "mas" fishing and curing, I made inquiries of the boatman who took us back to the steamer from Minikoi, by name Muhammad Ismail. He appears to have travelled in South India and has a smattering of Tamil He says he possesses a knowledge not only of bonito capturing and curing as followed in Minikoi, but also a fair knowledge of the Laccadive sea in general. In his opinion this particular fish is available everywhere as also the bait required, and that the processes can be easily taught to the other islanders. He is willing to undertake the special work. He expects the period of training required will take not less than six months, but with regard to the remuneration expected by him, he is not specific. If the administrative authorities open the question, it seems to me, there is every likelihood of this man (or any other) taking up the work.

General fishery prospects and conclusions.—From my observation, study and inquiry into the methods of fishing and curing adopted by the islanders, and also taking into consideration the knowledge and experience of the department in deep-sea fishing methods (which is practically the case with the fishing from these islands, for we get into great depths a few yards off the reef), I am of opinion that we cannot render any advice, other than theoretical, in the matter of improving catches and curing. It seems to me that if we can try to create a market for their cured fish, for which again experiments should be made for the supply and distribution of duty-free salt through the present Government agency, the fishing and curing will improve of themselves. It is the want of a suitable market which causes the fishermen to restrict their attempts to catch more fish. As described elsewhere only lining and spearing are adopted generally, and the long drag net from the shore is only a subsidiary method practised during low tides. The cast net is used only as an occasional method to obtain a supply for their daily curry. The big fishes caught by lining and harpooning are now consumed, more or less fresh, and the creation of a market for salted fish, and salt supply, free or at concession rates,

ought to give an impetus to better curing and storing of these big fishes. The fishermen are experts in handling lines, harpoons, nets and other fishing tackle, and will easily adapt themselves to new methods if only shown their efficacy. The flying-fish is found in all seasons and the fishermen will perhaps take trouble to catch more of this fish if a market is assured for the cured product. In my opinion, if a market can be created for their salted and other cured fish, an impetus will naturally follow for catching more fish and that again will tend to improve their boats and nets.

As a preliminary to, and simultaneously with, the measures suggested above, the Fisheries Department might purchase one or two small boats (costing between Rs. 30 and Rs. 100) in use in the islands and instal in them low-powered motors to test the suitability of power-driven boats for the island waters. At present it appears to me that fishermen labour at a disadvantage in having to row, at times for a long distance, to and from the fishing banks, and thus find themselves very tired for actual fishing work. The boats are easily and cheaply constructed (good, small, serviceable ones are offered even for Rs. 30), and with power added the industry is likely to take a new turn.

Ambergris.—This is one of the valuable marine products of the islands. It is in high demand by the native physicians of the mainland for use in general medicine, and also as a preventive of child bearing when taken by females. The selling price varies from Rs. 5 to Rs. 50 per tola (rupee) weight according to the quality. At least three qualities are recognized by the people and the trade, e.g., Ponnamber, Pūvamber and Mīnamber, meaning "gold," "flower," and "fish," and having yellow, light green, and black appearance, respectively. In spite of the rumours that good quantities are available, I was not able to ascertain the whereabouts of a stock in any of the islands, but at Kadamat I got a sample of Mīnamber. It is black in colour and a dirty smelling product. The other two kinds did not come to my notice. Their origin is stated as follows:—During the cold and wet months a kind of tallow-like mass is found floating in the sea and also washed ashore. Some have picked it up of the size of an orange and a stray find of a very big mass, some 20 years ago, is also rumoured. It is supposed by the islanders to be an exudation or excreta of some "sea elephant"; and as other sea animals, such as fish and crabs, know it by smell, they are said to eat away a

good quantity (?). When picked up it is wet and gives out a very rank odour. The islanders wrap it in cloth and in course of time it dries and the product is very carefully preserved.

Pearls.—As described above, the people of these islands are not acquainted with the pearl oyster. They think any round form of white or coloured hard substance picked from any bivalve shell may be called a "pearl" *(muthu)*. An inferior kind of pearl is obtained from a species of Modiola which was shown to me at Agatti, enormous beds of which exist at Androth. A fisherman at Kiltan told me that some three years ago a pearl *(Kalmuthu)* from Tridacna (the giant clam, Malayalam *Valiyakakkā*) was obtained there; Pinna also may occasionally contribute a few. I have not seen specimens of any of these. The real pearl oyster is available, but none of the people know it as such, and until we discover the locality of beds of mature ones during a more thorough scientific examination of the islands than the present one, we will have to be satisfied with the statement that pearl oysters are present in all the islands.

In this connexion the suggestion that Trochus and Turbo, found in big sizes in some of these islands suitable for pearl-button making, might be available in such quantity as to be commercially valuable was inquired into in greater detail. Without further knowledge gained by an exhaustive investigation to find out their abundance, we cannot come to any satisfactory conclusion on this question.

Edible molluscs.—Inquiries in all the islands showed that the poorer people eat molluscan flesh either baked in the fire or made into curries with suitable spices, etc. In almost all the islands plenty of Mesodesma shells are found near inhabited houses and the people say they eat this at times. The big *Paikalan* (*Ptero-cera lambis* and *P. chiragra*), with various big Conus, and Trochus and Turbo, contribute as food in times of distress and want. The boys and girls at Chetlat during our visit were seen sitting round a fire busy munching the baked flesh of *P. chiragra*, which is found in good numbers around this island. In almost all the islands I saw plenty of empty Strombus shells, but I am not able to discover for what purpose these have been collected. The people say that they possess very little flesh and are not eaten.

Turtles and turtle and fish oils.—It is a well-known fact that turtles are available in large numbers in almost all the islands and

the suggestion was made by Mr. Hornell in 1908 as to the opening of a fresh turtle trade, in his report in Bulletin No. 4. Till that is accomplished, it is for consideration whether the large quantities of crude oil now prepared from the fat and liver of turtles, sharks and rays, may not be used for some industrial purposes. No doubt the quality now prepared and in use is not to be recommended as it is very bad smelling and dirty looking in appearance. But if a satisfactory price is offered for a better quality we may be able to encourage the extraction of the oils and thus stimulate production on improved lines. At present the use to which the islanders put these, is to smear over their big Kundara boats and also over some of the smaller sized ones, as a preventive against desiccation and also against worm attacks. I brought with me a small quantity of these oils as samples, and this has been sent to an analyst that we may obtain information as to their probable industrial value and uses.

Report No. 3 of 1922.

THE GREY MULLETS OF TUTICORIN

BY

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INTRODUCTION.

When I assumed duties as Marine Biologist in the Fisheries Department of the Madras Government in September 1919, one of the subjects under investigation by one of the sub-assistants was the determination of the various species of mullets which are found in Tuticorin waters, and in particular, in the Silavatturai Lagoon at Tuticorin. This young sub-assistant had found, what others had previously discovered, that the mullets form a group whose species it is most difficult to determine.

Beyond supervising the work of the sub-assistant mentioned, and giving what hints I could in the time I could devote to the matter, I myself did nothing with the mullets until the sub-assistant left the service of the department on 21st June 1920.

After that date, I took up the matter alone, and spent some time in getting acquainted with these fishes in a general way. This preliminary survey being accomplished, I drew up tabulated sheets with a view to entering up the details of the characters of the different forms.

The work of counting scales and determining proportions in many scores of specimens proved extremely trying, particularly with those species which so closely resemble one another. Revision after revision often seemed to result only in greater confusion, until finally, one by one, the species became separable.

The primary idea was to establish for each species such constants as would make it possible for officers of the Fisheries Department to determine at sight the various species. To some extent this has been possible, though in one or two cases, I fear I have not been wholly successful, and a close examination is still necessary.

The work was carried on vigorously until the Government of Madras decided, in May 1921, not to maintain a Marine Biologist; hence a sudden rounding off in the work was necessary, and a series of further confirmatory examinations of the material, and comparisons with mullets from elsewhere was made impossible. The present paper is therefore scarcely as complete as I could have wished, but my endeavour has been to describe the various species in such a way that any one who desires to know them may, at a glance, assign a specimen to its place; this in particular for Fisheries officers. In addition, points have been given which involve more than a mere cursory examination on the beach, and it is hoped that these will be found useful for zoologists interested in these fishes.

I desire here to mention that I have received much courteous help from Dr. B. L. Chaudhuri of the Zoological Survey of India, who has kindly given his opinion on several occasions; a debt of gratitude I also owe to the sub-assistants lately working in my office at Tuticorin, in particular to Mr. Jayaram Nayudu who has given much care to the selection of fishes from catches, and supplied points concerning the methods of fishing which may have escaped me.

SILAVATTURAI LAGOON.

The Silavatturai Lagoon is a sheet of shallow water, only in a few places more than four feet deep at low tide; it is roughly rectangular, about 1,750 yards long and 600 yards broad, extending in a northerly direction, with two openings to the sea facing south-east. The floor of the lagoon is for the greater part of soft dark mud; there is little vegetation found, and that in one part only.

All fishing in the lagoon is under the control of Government, and apart from the fishing conducted by men employed by the Fisheries Department, outsiders are allowed to fish under certain conditions. Mullets are the commonest of the more valuable fish found there, and during the month of October large numbers of mullets, a little over one centimetre long, are to be found at the water's edge, and in the small channels leading from the main sheet of water.

For some time (September 1919 to March 1920) the lagoon was closed at the entrance, and a controlling sluice built, with the intention of converting the lagoon into a fish farm; but the experiment was abandoned owing to extensive damage caused by an excep-

tional storm, and the lagoon has reverted to its original nature. During the period of closure, the water reached a high degree of salinity, and though many fishes perished, the mullets survived the trying conditions and were apparently not affected; their adaptability in this respect is astonishing.

METHODS OF FISHING.

Fishermen come to the lagoon at certain times with the definite expectation of obtaining mullets as the principal constituent of their catch. The most auspicious conditions to the fishermen are high tide periods and a strong westerly wind; good hauls are expected particularly in June and July.

When the tide has receded to its full extent, a gill net called the "kalamkatti valai" is buried in a shallow trench excavated in the sand or mud near the water's edge. The incoming tide passes over the buried net and brings its quota of fishes; then at the turn of the tide, the net is raised above the water and staked in this position. A screen is thus erected to prevent the escape of the fish with the receding tide, and when the water is well down, the fishes are taken in baskets. The area so enclosed corresponds to the high and low water marks, and may be about 30 yards broad, depending, naturally, upon the slope of the shore.

Mullets are captured in the lagoon along with larger fishes, such as *Lates calcifera*, by means of a drag net, but the kalamkatti valai is unquestionably the mullet net. This net is used also on sandbanks which are only exposed at low tides, and in this case, the net, or series of nets united, is arranged in a wide circle.

Mullets are sportive fishes and can jump to considerable heights above the water; the antics and vocal demonstrations of the fishermen, designed to prevent the escape of fishes over the net, are, to say the least, amusing.

Fishing generally occurs twice a month, during the periods of highest tides, and then three or four catches are made on alternate days in each period. In a good catch, the quantity of mullets obtained may exceed 100 lb., the sale of which may be expected to realize Rs. 15, provided the fishes are of fair size; small-sized fishes in the same quantity would scarcely realize Rs. 6. Intending purchasers attend the fishery and bid for the catch, which is immediately removed for sale, since mullets begin to putrefy after a few hours in the warm climate.

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LITERATURE.

The literature on mullets is comparatively scanty, and not a little confusing; I have not been able to consult the papers of earlier writers such as Cuvier and Forskal, nor all those of later contributors. Day's classic work on the fishes of India and Günther's "Catalogue" have been the principal works consulted.

It is evident from the literature that workers have found the group difficult, and their descriptions include many contradictions and much overlapping in the ranges of variations. Thus one frequently has specimens which answer almost equally to the descriptions of two different species.

The value of systematic literature is much reduced by the failure of authors to describe the *same* features in *each* of the species described; any comparison therefore becomes impossible; Day's descriptions are notably weak in this respect, important characters frequently being omitted from them.

SPECIES AND NOMENCLATURE.

Day (3) enumerates no less than 27 species of mullets to be found in Indian waters, freshwater and marine, all under the genus *Mugil.* I am able to distinguish but eight species in Tuticorin waters.

After many repeated close examinations of a large number of specimens, I have found it impossible to recognize *Mugil cunnesius* (Cuv. & Val.) though Dr. Chaudhuri identifies this species from specimens sent to him from Tuticorin. Some species have close resemblances; for example *M. planiceps* (Cuv. & Val.) and *M. jerdoni* (Day) are easily confused, not only from their general appearance, but also by resemblances in detail.

Jordan and Seale (5) regard *Mugil (Liza) troschelii* (Bleeker) and *Mugil (Liza) borneensis* (Bleeker) as synonymous species with a preference for the former name; but one of the commonest mullets of Tutitcorin corresponds more closely with the descriptions of *M. troschelii* than of *M. borneensis*, hence this fish has been described as *Liza troschelii.*

Now Jordan and Swain (6) have proposed that the members of the genus *Mugil* should be distributed between two sub-genera, according to the presence or absence of adipose eyelids; *Mugil* is reserved for those with these eyelids, and *Liza* includes those in which they are absent. The distinction is quite a sharp one, and

only rarely need one be in doubt as to whether a specimen may safely be regarded as possessing adipose eyelids. This division into sub-genera has been adopted here, and for the eight species described, four belong to *Mugil* and four to *Liza*.

The species recognized from Tuticorin waters are:—

(1) *Mugil cephalotus* Cuv. & Val. (*Mugil oeur* Forsk.).
(2) *Mugil planiceps* Cuv. & Val.
(3) *Mugil jerdoni* Day.
(4) *Mugil kelaartii* Günther.
(5) *Liza troschelii* (Bleeker).
(6) *Liza amarula* (Cuv. & Val.).
(7) *Liza caeruleo-maculata* (Lacépède).
(8) *Liza waigiensis* (Quoy & Gaimard).

THE CRITERIA.

MEASUREMENTS.

1. *Length of body.*—The practice generally adopted in the past for measuring the length of the body of fishes has been to include the caudal fin in the measurement; but it has recently been pointed out that since the caudal fin is only comparable to other median fins, it should not be included, any more than a dorsal or anal fin is included in the measurement of the depth of the body. While recognizing the force of this argument and sympathizing with it, I have, nevertheless, included the caudal fin in the measurement of the total length, and therefore in the proportions, given here. And for the following reasons: there is absolutely no difficulty in determining the length when an overall measurement is taken; it is arbitrary and quite definite, allowing of no individual opinions as to limits. If, however, the caudal fin be omitted, there at once arises the necessity of deciding the exact line passing vertically through the base of the fin; different workers may fix different points, particularly when, as in the case of mullets, there is no sharp finish to the base of the caudal fin.

A practical point is also involved: when large numbers of fishes are to be measured, the time taken becomes an important factor, and the figure can be much more readily determined when an overall measurement is taken; much hesitation results from attempting to measure to the base of the caudal, for to be exact, the fish must be removed slightly from the measuring scale, and a line continued through the base of the fin to the scale.

Inclusion of the caudal fin also has the advantage of bringing the resulting proportions in line with those of earlier writers, and a proportion based on the newer method makes comparison practically impossible. I believe we can afford to waive a nice morphological point in favour of practicability, so long as the end in view does not suffer.

2. *Length of head.*—The length of the head has been measured by placing the snout of the fish in contact with a vertical surface, and, by means of dividers, measuring the distance from the vertical to the posterior edge of the operculum.

3. *Snout.*—Similarly for the snout, the measurement has been taken from the vertical mentioned to the front edge of the orbit by means of dividers.

4. *The eye.*—In general, the diameter of the eye is easily measured with dividers ; but where thick, and, after immersion in spirit, rather opaque, lids are present, there arises some difficulty. In some cases, I have found it necessary even to remove the eyelid before taking the measurement.

5. *Interorbital space.*—The distance between the dorsal edges of both orbits has been measured directly by dividers.

6. *Mandibular angle.*—Angles varying from 105 to 118 degrees were cut from cardboard in order to measure the angle between the rami of the lower jaw. An angle from 110 to 112 degrees, being the commonest met with, was regarded as "normal"; if below this figure, the angle is described as "acute," clearly using this term not in the strict mathematical sense, but only in comparison with the normal. Similarly, when the angle exceeded 112 degrees, it is spoken of as "obtuse." I fully appreciate the possible objections to this misuse of terms, but hope to justify it on practical grounds; this angle, in all the mullets I have examined, was, strictly speaking, obtuse, hence the difficulty in conveying the degree of obtuseness without circumlocution ; figures are of little use unless a measuring gauge is employed. It may be noted that those which I have called acute do, in general appearance, appear in comparison with the normal to be practically a right angle ; measurement proved them to be greater, but I am inclined to think that those which Günther described as a right angle were probably actually greater.

7. *Height of body.*—The greatest height, or depth, of the body was measured directly by means of dividers ; it should be remembered that varying degrees of flaccidity or distention of the body does affect this proportion.

8. *Height of fins.*—The correct measuring of the height of fins is often difficult in preserved specimens, since the fin becomes quite rigid and may even break in an attempt to stretch it to its naturally extended position ; it is frequently impossible to extend the fin fully. I have therefore decided not to include relative heights of fins in these descriptions.

THE NUMBER OF FIN RAYS.

1. *The caudal fin.*—Much difficulty is experienced in the attempt to count all the fin rays in the caudal fin, owing to the fact that the very small rays at the edge of the fin are often indistinguishable, and only dissection could determine their exact number. I have never been able to make the numbers recorded by Day tally with specimens I have examined. In all counts therefore I decided to include only those rays which extend to the posterior extremity of the fin ; this was the method adopted by Bleeker. I have found that in all the mullets examined 14 such rays were present.

2. *The pectoral fin.*—In counting the rays of the pectoral fin, the use of a lens is essential ; for large specimens a watchmaker's eyeglass, and for small specimens a powerful hand lens, was used. It must be remembered that there is always, in the mullets, a fin ray very closely applied to the uppermost long ray ; this last closely applied ray is usually quite small, and, though often easily distinguishable, is liable to be overlooked.

Now, I have found that the number of rays in the pectoral fin of the same species is liable to variation, and a difference of as much as two has been observed ; in fact, on occasions, a difference of one has been noted between the two pectorals of the same specimen. This fact was very disturbing for a long time, since I had regarded the number of pectoral fin rays as a factor only rarely liable to variation. Particular care has throughout been given to the counting of these fin rays, and in the end I was obliged to regard their number as of no rigid importance for mullets.

SCALATION.

1. *The lateral line series.*—The counting of the lateral line series (which in the mullets, means any longitudinal series round the mid-lateral area) is fairly straightforward ; the principal difficulty is encountered at the base of the caudal fin, where the

small scales covering the base—not reckoned in the lateral line count—are not always sharply defined from the scales of the trunk. The count ends with the last scale having a sensory canal. The first scale counted is that immediately above the base of the pectoral fin, and behind the operculum. Care must be taken to account for those scales which have been lost, and if these are many, one must rely on the scale pockets, which are often not easy to deal with. The number in the lateral line series of all specimens in the same species is not quite constant; but within a certain range (at most 3 or 4) there is constancy.

2. *The lateral transverse series.*—Speaking generally, for purposes of counting the number of rows of scales in the lateral transverse series, the mid-ventral and mid-dorsal line is omitted; thus only truly lateral scale series are taken into account.

Between the two dorsal fins, however, we frequently find no mid-dorsal scales present; not a single scale is median for this length, the median series being represented by two short lateral series, which do not generally extend beyond the limits of the fins. Since their limits are so restricted, these short series have not been included in the count of the lateral transverse series.

The mid-dorsal series between the two dorsal fins may, however, be represented by any number up to six scales—which figure practically represents a complete series between the fins in question ; one, two, three, etc., only may be present, before the series divides into two lateral ones. The number of scales present in this mid-dorsal line does not appear to be distinctive of species, but rather to be an individual variation.

Occasionally, the two intercalated lateral series mentioned do extend a little beyond the origin of the second dorsal fin, even to its posterior limit; and anteriorly, they may include the elongated scales found at the base of the first dorsal fin. But this series seldom proceeds further forward than the first dorsal fin.

Mid-ventrally, too, it is not always a simple matter to decide which line of scales can be regarded as mid-ventral; short intercalated series are sometimes present, and sometimes a lateral series "gives out" before the vent is reached. But here also, complete series only have been taken into account.

The number of rows in the lateral transverse series very frequently differs on the two sides of the same specimen; but

the difference is never greater than one. The count is taken from between the two dorsal fins on the dorsal side to between the pelvic fins and the anus on the ventral side.

3. *Frontal scales.*—Descriptions frequently include the number of scales present between the first dorsal fin and the end of the snout, but I have found that in the vast majority of mullets an accurate count of these scales was impossible, owing to their irregular disposal and, still more, to the damage, nearly always found, to the scales on the top of the head. I have therefore been obliged to ignore this character in these descriptions.

4. *Elongated scales.*—In all the specimens of mullets which I have examined, I have found an elongated scale at the base of the first dorsal fin and the pelvic fins; usually, the scale is distinctly elongated, but sometimes somewhat reduced. Some specimens have two elongated scales at the base of the dorsal fin on each side, and these two overlap; they are sometimes the beginning of the additional short longitudinal series between the first and second dorsal fins.

An elongated scale is also found in certain species in the axil of the pectoral fin; the raising of this fin reveals this scale, which is usually pointed. In other species, there is no trace of a scale which can be designated axillary; however, a short, blunt, soft, scale may be present in this position, but such a scale has not been regarded as an axillary scale in these descriptions, the name being reserved for the elongated form. Where it is absent, it is quite possible that the elongate axillary scale may have become detached; I have found it quite loose and easily detachable, and in some cases it has been present on one side, but not on the other; hence, in specimens which tally completely with the type except for the possession of the elongated axillary scale, it is well to consider the possibility of its having become detached.

THE POSITION OF FINS.

1. *The dorsal fins.*—One of the most reliable points for identification purposes is the position of the dorsal fins in relation to the scales of the lateral line; a fair degree of constancy in this character is maintained for each species, particularly in the case of the first dorsal fin; in fact, a recorded variation of more than one is usually attributable to an error due to difficulty in counting. With the second dorsal fin, a variation of two may be met with; for example, if for a particular species, the first dorsal normally begins above the 11th scale of the lateral line, specimens may be

found in which it originates above the 10th, but if the 21st scale is normal for the origin of the second dorsal fin, cases will be found where a count will show the origin to be above, say, the 23rd.

By dropping a vertical line from the origin of the second dorsal fin across the tail to the base of the anal fin, the "advance" of the anal before the second dorsal is determined; the origin of both may be in the same vertical line—in other words opposite one another; or the anal may have a fraction of the length of its base in advance of the dorsal. This is a reliable character, and one in which little variation occurs.

2. *Proportions.*—For a group like the mullets, where the several species so closely resemble each other, the value of proportions is of secondary importance. The range of variations causes much overlapping in the proportions of the various species and several species have almost identical proportions. Young specimens frequently show different proportions from those of the adults; they also require the most exact measuring, since, in small measurements, such as the length of the snout, or the diameter of the eye, the smallest error makes a considerable difference in the resulting proportions. For mullets, therefore, I can only recommend the use of some proportions as corroborative evidence; it is impossible to consider them as of primary importance.

3. *Colour.*—Bluish grey above and silvery below very well describes the general colour for all the grey mullets; the differences in colour are, in the main, differences in detail only. The presence of a dark spot at the base of the pectoral fin is a most useful character; dark tips to the median fins must be distinguished from a mere darker edge to these fins, or the character is liable to become universal for mullets; dark lines along the rows of scales in the upper half of the body is often a useful character. However, striking differences in colouration are not found among the mullets.

DESCRIPTIONS OF THE SPECIES.

MUGIL CEPHALOTUS *Cuv. & Val.*

M. œur Forsk. and Day.

D. 4 | 1/8. A. 3/8. L. l. 40-43. L. tr. 14.

This mullet, which attains considerable size, commonly 18 inches, is a common species in Tuticorin; it can be readily identified by the following features:—

(1) The broad and flattened upper surface of the head;

(2) the broad and very thick adipose eyelids, which extend some distance across the pupil of the eye;

(3) the dark blue band across the base of the pectoral fin; and

(4) the peculiar shape of the lower jaw, the mandibles bending towards the middle, at the angle of the mouth.

The detailed characters are enumerated below:—

Adipose lids.—Present; very thick and broad, extending to, or even beyond, the edges of the pupil.

Interorbital space.—Broad and flat; twice the diameter of the eye across. Both Günther and Day describe the width of this area as more than twice the diameter of the eye.

Uncovered chin space.—Wide, and often constricted about its middle.

Mandibular angle.—The angle between the rami of the lower jaw is comparatively acute, approaching a right angle, and at the angle of the mouth the mandibles turn inwards towards the middle line.

Preorbital bone.—Scaled and serrated on the posterior and ventral edges; it is scarcely at all bent, and is not prominent.

Maxilla.—The end of the maxilla is entirely hidden.

Pectoral fin: Rays.—The number of fin rays usually present in the pectoral fin is 17, but one specimen examined gave 16 only, while another possessed 18 rays. These latter are exceptional. Day's formula gives 15 rays only, but I have never found less than 16.

Extent.—The fin reaches to the 10th to 12th scale of the lateral line, that is, a little short of the origin of the first dorsal fin. This agrees with Day's description, but Günther places the extremity of the fin at the 8th scale.

Axillary scale.—An elongated axillary scale is always present in the axil of the pectoral fin.

Lateral line series.—42 scales are typically present in this series, but 40, 41 and 43 have been counted in several specimens. Day gives 42 to 44, but Günther only 38 to 40.

Lateral transverse series.—14 complete rows of scales are present on each side of the body; this excludes a short series which extends only between the two dorsal fins, where no median series is found. In one case, there were 14 on the right side and 15 on the left.

Origin of the dorsal fins.—The first dorsal fin very consistently originates above 13th scale of the lateral line, only one exception was found in which there was a variation, and here the fin originated above the 14th scale. The origin of the second dorsal fin is variable, viz., from the 25th to the 27th scale.

In this particular, I find the Tuticorin specimens in close agreement with Day's description, but Günther's figures are distinctly short, being 10—11 and 22—23 for the origins of the two fins respectively.

Position of the anal fin.—The anal fin is only very slightly in advance of the second dorsal.

Proportions.—The total length of the body is 4¾ to 5 times the length of the head.

The length of the head is 4½ to 5 times the diameter of the eye.

The snout is a little shorter than the diameter of the eye.

The height of the body is somewhat less than the length of the head.

The least depth of the tail is less than ½ the length of the head, and about ⅔ the length of the postorbital part of the head.

The length of the pectoral fin is a little short of the length of the head, not including the snout.

The first spine of the first dorsal fin is about ⅔ the length of the head, or a little short of the length of the postorbital part of the head.

The third anal spine is less than ⅓ the length of the head.

Colour.—There are no striking peculiarities in colour beyond the very prominent dark blue splash across the base of the pectoral fin.

MUGIL PLANICEPS *Cuv. & Val.* and *Günther.*

M. dussumieri, Day.

D. 4 | 1/8. A. 3/9. L. l. 31. L. tr. 10-11.

This species must be regarded as one of the commonest of the mullets in Tuticorin, and one of importance as a food fish, since it is commonly 16 cm. to 20 cm. in length. The features which characterize this species as compared with others in Tuticorin waters are few; indeed it would perhaps be safer to say that it is the absence of very definite general characters which makes the species readily distinguishable. There is very little by which to distinguish *M. planiceps* from *M. jerdoni*; in fact from superficial

characters, there would seem little justification for regarding them as distinct species; the form of the head, and the proportion of the eye to the head are the only features by which the two seriously differ. For this species, as a laboratory instruction, I have been in the habit of giving "flat head, and no special peculiarities" as features for its identification. Details are given below: —

Adipose lids.—Present; anterior one narrow, posterior broader; the latter occasionally even reaching to the pupil.

Interorbital space.—Flattened; 1¾ to 2 times the diameter of the eye across.

Uncovered chin space.—Moderately wide; constricted about its middle; the anterior part rounded.

Mandibular angle.—The angle between the mandibular rami is "normal," that is, 110 to 112 degrees.

Preorbital bone.—Scaled; it is strongly bent and serrated posteriorly and ventrally.

Maxilla.—The end of the maxilla is distinctly visible.

Pectoral fin: Rays.—The normal number of fin rays in the pectoral fin is 16; one specimen examined showed 17 rays.

Extent.—The fin reaches as far as the 8th scale of the lateral line; in one specimen, it reached to the 9th, while in one other it only extended to the 7th. Günther gives the extent as the 8th scale, and Day as the 7th.

Axillary scale.—No elongated scale is present in the axil of fin, but sometimes a short stumpy scale is found.

Lateral line series.—Most commonly 31 scales are found in the lateral line, but 30 and 34 are the extremes met with in specimens examined. Day credits this species with 29—31 scales and Günther with 33—35.

Lateral transverse series.—10 or 11 rows of scales may be present on either side of the body; some specimens have 11, others 10, on each side, while others again shew 10 on one side and 11 on the other. The differences observed seem to depend on the relative prominence of an additional series, which is nearly always met with near the mid-ventral line; this series may be so short as to be inadmissible as a series, or it may rank as a complete one, adding to the side on which it occurs. Both Günther and Day give 11 rows for this species.

Origin of the dorsal fins.—The 10th and 21st scales of the lateral line may be regarded as those corresponding to the origin

of first and second dorsal fins respectively. My records give two exceptions only, viz., the 9th and 20th in one case, and the 11th and 22nd in the other; but it will be seen that here, too, the same relative position is maintained. One less or one more may, however, frequently result from error, or difficulty, in counting; this possibility is all the more probable since, in the two cases mentioned, the reach of the pectoral fin was also respectively one less and one more, viz., 7th and 8th scale. Günther places the origins at the 10th to 11th and 22nd to 23rd scales, while Day places them at the 9th and 20th.

Position of the anal fin.—The anal fin is advanced by about ½ of the length of its base before the origin of the second dorsal.

Proportions.—The total length of the body is 5 to 5½ times the length of the head.

The length of the head is 3½ to 4¼ times the diameter of the eye, but in most cases 4 times exactly. In this respect the eye is distinctly smaller proportionately than in *M. jerdoni.*

The length of the snout is about ¾ of the diameter of the eye.

The length of the head and caudal fin, and the height of the body are about equal.

The least depth of the tail is equal to the length of the post-orbital part of the head, or more than half the total length of the head.

The length of the pectoral fin is equal to that of the head, not including the snout.

The first spine of the first dorsal fin is about ⅔ the length of the head.

The length of the third anal spine is a little more than ⅓ of the length of the head.

Colour.—This fish presents no striking colour characters, but the edge of the second dorsal and the extremity of the caudal are often dark; faint lines are frequently present along the rows of scales in the upper half of the body.

The first dorsal fin is stout, and the first spine is stronger than the rest. The second dorsal, caudal and anal fins are heavily scaled.

MUGIL JERDONI *Day.*

D. 4 | 1/8. A. 3/8-9. L. l. 30. L. tr. 10.

As already mentioned, this species is difficult to distinguish from *M. planiceps,* with which it has much in common. The

enumeration of the points of difference in the two species therefore is advisable, before the fuller description is given.

(1) The interorbital space is slightly convex, whereas in *M. planiceps* this area is distinctly flattened. The terms "slightly convex" and "flattened" may not appear to be quite sufficiently distinctive, and it must be admitted that, occasionally, the difference may be a matter of opinion. At the same time, when the two species are viewed together in profile, the difference is fairly obvious; the snout of *M. jerdoni* appears blunt, while that of *M. planiceps* looks pointed and depressed.

(2) The mandibular angle is distinctly obtuse when compared with that of *M. planiceps*, which latter has been described as "normal."

(3) The diameter of the eye, proportionately to the length of the head, is greater than in *M. planiceps.*

(4) The number of scales in the lateral line are fewer in general than in *M. planiceps*; they range from 29 to 31, most usually 30; while in *M. planiceps* they number from 31 to 34.

(5) The lateral transverse series never exceeds 10. *M. planiceps* may have 11.

(6) While in M. *planiceps* the pectoral fin has 16 rays, never less, *M. jerdoni* has 15 equally frequently as 16.

While most of these points in themselves are not conclusive characters, used in conjunction they are sufficient to distinguish the two species in question.

The detailed description is as follows:—

Adipose lids.—Present; the posterior one is broad, reaching the pupil, while the anterior one is narrower.

Interorbital space.—Slightly convex. 1½ to 1⅔ times the diameter of the eye across.

Uncovered chin space.—Of medium width, constricted in the middle and rounded anteriorly.

Mandibular angle.—The rami of the lower jaw meet at a pronounced obtuse angle; measured in degrees the angle shews a range of 115 to 118. In only one case could the angle be spoken of as "normal," i.e., 112°.

Preorbital bone.—Scaled, serrated posteriorly and ventrally; its strong bend approximates to a right angle.

Maxilla.—The end of the maxilla is distinctly visible.

Pectoral fin : Rays.—The number of fin rays is 15 or 16; either number is equally common.

Extent.—The extremity of the pectoral fin reaches to the 7th or 8th scale, rarely to the 9th, of the lateral line; hence it falls distinctly short of the origin of the first dorsal fin.

Axillary scale.—No scale which can be called an elongated axillary scale is present, but sometimes a very short pointed scale is found in the axil of the fin.

Lateral line series.—The commonest number of scales in the lateral line is 30; 29 or 31 may also be met with.

Lateral transverse series.—Every specimen but one that has been examined shewed 10 rows of scales on each side of the body, the one exception gave 9 on the right side and 10 on the left. It should be noted, however, that between the two dorsal fins is a secondary series not included in the count, and there is no median series in this position.

Origin of the dorsal fins.—Most commonly the first dorsal fin originates above the 10th scale of the lateral line; sometimes above the 9th or 11th. The second dorsal starts above the 19th to the 21st scale, usually the 20th.

Position of the anal fin.—Half the base of the anal fin is in advance of the second dorsal.

Proportions.—The length of the body, overall, is $4\frac{2}{3}$ to $5\frac{2}{3}$ times the length of the head.

The length of the head is a little more than 3 to $3\frac{2}{3}$ times the diameter of the eye.

The snout measures $\frac{2}{3}$ the diameter of the eye in length.

The height of the body is frequently greater than, and the caudal fin equal to, the length of the head.

The least depth of the tail is equal to the length of the post-orbital part of the head, or more than $\frac{1}{2}$ the total length of the head.

The length of the pectoral fin is a little short of the length of the head, not including the snout.

The length of the strong first spine of the first dorsal fin is $\frac{2}{3}$ or more of the length of the head.

The third spine of the anal fin is $^{3}/_{7}$ or $\frac{1}{2}$ the length of the head, or equal to the width of the interorbital space.

Colour.—The tips of the dorsal and caudal fins are dark; the iris is also dark in colour; there is usually a dark spot above the centre of the eye.

This species attains to a fair size; specimens 17 cm. or 20 cm. in length are commonly met with.

MUGIL KELAARTII *Günther*.

D. 4 | 1/8. A. 3/9. L. l. 33-34. L. tr. 11-12.

On the whole, the descriptions given by Day for *M. cunnesius* and *M. kelaartii* are fairly similar; Günther's accounts for these two, however, differ markedly. While the Tuticorin specimens agreed almost equally with either *M. cunnesius* or *M. kelaartii* as described by Day, they conform decidedly more to Günther's *M. kelaartii* than to his *M. cunnesius*; further, Günther records *M. kelaartii* as a Ceylon form, and it is likely that it would also be found at Tuticorin.

For rapid identification, the following characters will be found sufficient:—

(1) The upper surface of the head rather convex.

(2) The knob-like end of the maxilla is not visible at the angle of the mouth, when the latter is closed.

(3) The pectoral fin reaches to, or slightly beyond, the origin of the first dorsal fin.

(4) An elongated scale is present in the axil of the pectoral fin.

(5) Colour: a definite black spot at the upper base of the pectoral fin, and the tips of both dorsals and the caudal black.

The detailed characters are as follow:—

Adipose lids.—Present; large, but neither is "fleshy", and as a rule, neither quite reaches the pupil. Günther remarks that they are "very broad, covering the greater part of the iris," but Day states that both posterior and anterior eyelids are narrow—a remarkable contradiction of the original description by Günther.

Interorbital space.—Rather convex; 1½ to 1¾ times the diameter of the eye in width.

Uncovered chin space.—Usually narrow, constricted in the middle and rounded anteriorly.

Mandibular angle.—The angle formed by the union of the two rami of the lower jaw, measured in degrees is variable. Some specimens shewed 105, others 112 degrees, but the commonest angle

was 110 to 112 degrees. Günther describes this angle as being a right one, but I have not met with any where the rami were so closely approximated.

Preorbital bone.—Smooth and not scaled; serrated posteriorly, and ventrally, and slightly bent.

Maxilla.—The end of the maxilla is usually completely hidden though in some cases it is just visible. Günther states that this bone is entirely hidden, while Day describes it as having "the extremity visible."

Pectoral fin : Rays.—16 was the commonest number seen, but 15 rays were also quite common; 17 was reached in three cases, and in one case 16 were present on one side, and 17 on the other. Day gives 15 rays.

Extent.—The extremity of the fin reaches as far as, or slightly beyond, the anterior border of the first dorsal fin; i.e., as far as the 11th to 13th scale of the lateral line; most commonly it is the 11th and rarely the 13th. This agrees with Günther's remarks.

Axillary scale.—An elongated scale is present in the axil of the fin; it is always prominent.

Lateral line series.—The usual number of scales in the lateral line is 33; 34, and occasionally even 35, were also met with.

Lateral transverse series.—There are 11 rows of scales on each side; but in two cases 12 were found on the right side and 11 on the left; one specimen shewed 12 rows on each side. Günther gives 12 as the number of rows, while Day records 10; Tuticorin specimens therefore tend to agree more closely with Günther's description.

Origin of the dorsal fins.—Most commonly, the first dorsal fin begins above the 11th scale in the lateral line series, and the second above the 21st. Sometimes, when examined with particular accuracy, the first dorsal may be said to originate in the vertical between the 10th and 11th or between the 11th and 12th scales. The origin of the second dorsal may vary a little and lie above the 21st to the 23rd scale. Günther's description gives the 11th and 22nd and Day's the 10th and 20th as the scales of origin of the two dorsal fins.

Position of the anal fin.—One-third of the length of the base of the anal fin is in advance of the origin of the second dorsal fin; in some cases, it may be very slightly more or less.

Proportions.—The total length of the body is 5 to 5½ times the length of the head.

The head is usually 3⅓ to 3½ times the diameter of the eye (3·12 and 3·76 were the extremes actually met with).

The length of the snout is about ¾ of the diameter of the eye. Günther makes the length of the snout and the diameter of the eye equal, while Day states it to be "nearly one diameter."

The least depth of the tail is equal to the postorbital part of the head, and approximately half the length of the head, as stated by Günther.

The length of the pectoral fin is as long as, or very slightly longer than, the length of the head; but Günther says it is "somewhat shorter than the head."

The height of the body is rather greater than the length of the head, and approximately the same as the length of the caudal fin.

The postorbital part of the head is ½ of the total length of the head, or occasionally slightly greater than ½.

The first spine of the first dorsal fin is a little longer than the postorbital part of the head.

The length of the third anal spine is approximately $^2/_5$ of the length of the head.

Colour.—The distinctive colour features are a well-defined black axillary spot at the base of the pectoral fin, and black tips to the two dorsal and caudal fins. In spirit specimens, there is a fair amount of reddish brown at the base of the anal, pelvic and pectoral fins, as well as about the head.

The body is laterally compressed, and in preserved specimens, the myotomes of the body are usually clearly visible. Fairly large specimens caught at Tuticorin measure from 16 cm. to 20 cm. for the total length.

LIZA TROSCHELLI (*Bleeker*).

D. 4 | 1/8 A. 3/9. L. l. 32-34. L. tr. 10-11.

The specimens described under this name possess much in common with those described by previous writers as *Mugil troschelii* and *Mugil borneensis* (Bleeker); presumably, Jordan and Seale (5) had the same difficulty and regarded the two species as synonymous. Much of the difficulty arises from the absence of exactly

comparative descriptions, but the Tuticorin specimens perhaps shew a closer agreement with the descriptions of *M. troschelii.* At the same time, they shew features similar to *M. borneensis* as well as intermediate characters. *M. troschelii* is described by Günther as a Ceylon form, and it is therefore most likely that the species in question is the same. I am inclined to think that Jordan and Seale were quite justified in regarding these two species as synonymous.

Liza troschelii is very common at Tuticorin; it bears a close general resemblance to *Mugil planiceps,* but from which of course it is distinguishable by the absence of adipose eyelids. For immediate recognition, the remarks already made regarding *M. planiceps* apply here also. There are no striking characters, no marked colour characteristics; the features are :—

(1) No adipose eyelids.

(2) Head flattened.

(3) No elongated axillary scale.

(4) The end of the maxilla is visible at the angle of the mouth.

(5) The pectoral fin does not reach to the origin of the first dorsal fin.

(6) One-half of the base of the anal fin is before the origin of the second dorsal fin.

The detailed characters are as follow :—

Adipose eyelids.—Absent.

Interorbital space.—Flattened; its width is 1⅔ to 1¾ times the diameter of the eye.

Uncovered chin space.—Rather wide; constricted in the middle.

Mandibular angle.—The rami of the lower jaw meet at an angle of about 112 degrees, i.e., "normal."

Preorbital bone.—Scaled, and serrated posteriorly and ventrally; bent at the angle of the mouth, but not strongly; squarely truncated posteriorly.

Maxilla.—The extremity of the maxilla is exposed at the angle of the mouth.

Pectoral fin: Rays.—16 rays are present as a rule, but 15 have been noted.

Extent.—The fin reaches to the 8th scale of the lateral line, well short of the origin of the first dorsal fin.

Axillary scale.—No elongated scale is found in the axil of the fin, but sometimes a short blunt one is present.

Lateral line series.—The number of scales in the lateral line is 32 to 34.

Lateral transverse series.—10 or 11 rows of scales are present on the side of the body; there may be 10 on one side and 11 on the other of the same specimen.

Origin of the dorsal fins.—The first dorsal fin originates above the 10th or 11th scale of the lateral line, while the second dorsal fin arises above the 21st to 23rd scale.

Position of the anal fin.—About half of the base of the anal fin is in advance of the origin of the second dorsal fin.

Proportions.—The total length of the body is 4¾ to a fraction over 5 times the length of the head.

The length of the head is 3½ to 4 times the diameter of the eye.

The length of the snout is ¾ to 4/5 of the diameter of the eye.

There is little difference between the lengths of the head and the caudal fin and the height of the body, though the head measurement is usually slightly the greater.

The least depth of the tail is a little less than ½ the length of the head, and less than the length of the postorbital part of the head.

The length of the pectoral fin is a little less than the length of the head, not including the snout.

The length of the first spine of the first dorsal fin is usually a little greater than the length of the postorbital part of the head; occasionally it is of the same length.

The third anal spine is less than ⅓ the length of the head.

Colour.—No striking colour is to be noted; in some specimens the upper extremity of the second dorsal fin is dark.

This fish is fairly large and frequently exceeds 25 cm. in length.

LIZA AMARULA (*Cuv. & Val.* and *Day*).

D. 4 | 1/8. A. 3/9. L. l. 36. L. tr. 12.

I have not found it possible to give characters suitable for the immediate recognition of this species, which is easily confused with *L. troschelii*; the anal fin is in advance of the second dorsal by one-third of its base, but this can scarcely be useful for ready identification. It is only when details are considered that the distinction is established. However, this species is not a very common one at Tuticorin, and I have only met with three or four specimens, the

largest of which measured 16 cm. in length. Its characters are as follow:—

Adipose lids.—Absent.

Interorbital space.—Flattened; its width is 1½ to 1¾ times the diameter of the eye.

Uncovered chin space.—This is of moderate width, and is constricted in the middle.

Mandibular angle.—The rami of the lower jaw meet at an angle of about 112 degrees, i.e., the angle is "normal."

Preorbital bone—Not strongly bent at the angle of the mouth; scaled, and serrated posteriorly and ventrally.

Maxilla.—The end of the maxilla is exposed.

Pectoral fin: Rays.—There are 16 or 17 rays in the pectoral fin.

Extent.—The fin extends to the 9th scale of the lateral line series, falling well short of the origin of the second dorsal fin.

Axillary scale.—There is no elongate scale in the axil of the fin.

Lateral line series.—36 scales are present in the lateral line.

Lateral transverse series.—There are 12 rows of scales on each side of the body; one specimen shewed 12 on the right and 13 on the left side.

Origin of the dorsal fin.—The first dorsal originates above the 12th scale of the lateral line, and the second dorsal above the 24th.

Position of the anal fin.—The origin of the anal fin is in advance of that of the second dorsal by ⅓ of its base.

Proportions.—The total length of the body is 4¼ to 4¾ times the length of the head.

The length of the head is 3⅔ to $3^4/_5$ times the diameter of the eye.

The length of the snout is ¾ of the diameter of the eye.

The length of the head, the length of the caudal fin and the height of the body are approximately equal, but the length of the head is usually slightly the greatest.

The least depth of the tail is less than ½ the length of the head, and very slightly less than the postorbital part of the head.

The length of the pectoral fin is less than the length of the head, excluding the snout.

The length of the first spine of the first dorsal fin is equal to, or a little greater than the postorbital part of the head. The dorsal spines are strong.

The third spine of the anal fin is about ⅓ of the length of the head, a little more or a little less.

Colour.—There are no special features of colouration to be noted.

LIZA CAERULEO-MACULATA (*Lacépède*).

D. 4 | 1/8. A. 3/9. L. l. 39 L. tr. 14.

This handsome mullet is common in Silavatturai Lagoon; it may be identified at a glance by the following characters:—

(1) Dorsal surface of the head slightly convex from side to side.

(2) A dark bluish-black spot at the upper edge of the base of the pectoral fin.

(3) The presence of an elongated axillary scale in the axil of the pectoral.

(4) The pectoral fin reaches to the origin of the first dorsal fin.

(5) The spines of the first dorsal fin are weak.

(6) The origins of the anal and second dorsal fins opposite.

(7) The rows of scales across the body numerous (14).

(8) The uncovered space at the chin is very narrow or even obliterated.

The detailed description is as follows:—

Adipose lids.—Absent.

Interorbital space.—Slightly convex; sometimes may be regarded as a little flattened. Its distance across is as nearly as possible equal to twice the diameter of the eye. Bleeker gives a very wide range of variation here, viz., 1½ to 2½ times the diameter. Day gives it as ½ the length of the head, which corresponds with Tuticorin specimens.

Uncovered chin space.—Very narrow, and often practically absent, especially posteriorly, owing to the close approximation or overlapping of the opercular folds.

Mandibular angle.—"Normal," i.e., the rami meet at an angle of about 112 degrees.

Preorbital bone.—Either not at all, or but sparsely scaled serrated posteriorly and ventrally.

Maxilla.—The end of the maxilla is completely hidden.

Pectoral fin : Rays.—All the specimens shewed 18 rays, except in one case where there were 17 on one side and 18 on the other. Day states that this species has but 17 rays in the pectoral fin ; Bleeker mentions 18, but puts his formula for this fin in the form of 2/16, indicating 2 spines and 16 rays proper. Thus the Tuticorin specimens agree with Bleeker's description in this respect.

Extent.—The extremity of the fin reaches to the origin of the first dorsal fin or slightly beyond it, i.e., to the 12th or 13th scale of the lateral line. In one case it reached the 14th scale.

Axillary scale.—An elongated scale is always present in the axil of the pectoral fin.

Lateral line series.—Every specimen shewed 39 scales in the lateral line ; both Bleeker and Day record 38 only, but the difference is not important.

Lateral transverse series.—14 complete rows of scales are present on each side of the body, exclusive of a subsidiary series which extends only between the two dorsal fins ; no median series is present between the two dorsals. One specimen shewed 13 rows on the left side and 14 on the right. In this particular, the Tuticorin specimens differ considerably from the descriptions of Günther and Day, both of whom give the lateral transverse series as 12.

Origin of the dorsal fins.—The first dorsal fin originates above the 12th or 13th scale of the lateral line; most commonly, the second dorsal originates above the 26th scale, and occasionally the 25th ; Day places the origins at the 12th and 24th scales.

Position of the anal fin.—The origin of the anal fin is opposite to, or very slightly in advance of, the second dorsal fin.

Proportions.—The total length of the body is 4½ to 5 times the length of the head ; this is a much more restricted range of variation than that given by Bleeker, viz., 4¼ to 5⅔ ; Günther and Day give the proportion as 5 to 5⅔.

The length of the head is 3⅔ to 4 times the diameter of the eye, again shewing much narrower limits of variation than those allowed by Bleeker, viz., 3½ to 4½.

The length of the snout is usually 5/7 of the diameter of the eye, but may be 4/5 to 6/7.

The least depth of the tail is less than ½ the length of the head, and short of the length of the postorbital part of the head.

The length of the pectoral fin is less than that of the head by about ½ the length of the snout.

The length of the head, the height of the body and the length of the caudal fin are usually of about equal length. Günther and Day give the height of the body as somewhat greater than the length of the head.

The first spine of the first dorsal fin, the length of the post-orbital part of the head, and the width of the interorbital space closely approximate each other in measurement, i.e., a little more than ½ the length of the head.

The length of the third anal spine is ⅓ the length of the head.

Colour.—Preserved specimens shew the following colour features: a dark axillary spot is present at the upper base of the pectoral fin; there is a dark spot above the centre of the eye; the front edge of the second dorsal and the edge of the caudal fins are darkish; the first dorsal is frequently tipped dark; the base of the anal and pelvic fins brown; there is a brownish streak across the head a little behind the eye; and a white triangular patch behind and below the eye; the iris is light coloured.

The specimens of this species at Tuticorin do not seem to attain the size mentioned by Day who says an Andamans specimen measured 13 inches, "but it is said to grow very much larger." None of the specimens examined exceeded 14 cm.

LIZA WAIGIENSIS (*Quoy & Gaimard*).

D. 4 | 1/8. A. 3/8. L. l. 26. L. tr. 9.

This species is scarcely so common as other species described, except *L. amarula*; it is a small mullet, seldom more than 14 cm. in length. It is most readily identified by the following characters:—

(1) *Colour.*—(*a*) Fins: The pectoral and both dorsals have a considerable part of their surface black. The caudal fin is yellow with a black edge. The anal and pelvic fins are orange coloured with a black tip. Preserved specimens retain only the black markings. (*b*) Prominent dark longitudinal lines along the rows of scales.

(2) The caudal fin only very slightly forked.

(3) The pectoral fin reaches nearly, or quite, to the origin of the first dorsal fin.

(4) The number of rows of scales across the body is few (9).

A detailed examination reveals the following features :—

Adipose lids.—Absent.

Interorbital space.—Distinctly flattened ; its width is 2 to 2⅓ times the diameter of the eye.

Uncovered chin space.—This is rather variable in form, always rounded anteriorly, but posteriorly may be comparatively wide or of medium width, and sometimes even narrow.

Mandibular angle.—The angle between the two rami of the lower jaw is comparatively acute, measuring 103 to 105 degrees.

Preorbital bone.—Scaled ; serrated posteriorly and ventrally ; not strongly bent.

Maxilla.—The end of the maxilla is exposed.

Pectoral fin : Rays.—The number of rays in the pectoral fin is 16 or 17, more frequently the latter.

Extent.—It reaches as far as the 7th or 8th scale of the lateral line, i.e., as far as, or only a little short of, the origin of the first dorsal fin.

Axillary scale.—No elongated scale is present in the axil of the pectoral fin.

Lateral line series.—The scales in the lateral line series almost invariably number 26.

Lateral transverse series.—No exception has been found to nine complete rows of scales on each side of the body. Between the two dorsal fins is an additional short series.

Origin of the dorsal fins.—The first dorsal fin originates above the 8th scale, and the second dorsal above the 17th scale of the lateral line ; for the latter, the 18th has been occasionally noted.

Position of the anal fin.—One-half or slightly more of the base of the anal fin is in advance of the origin of the second dorsal fin. Day describes the advance of the anal as only ⅓.

Proportions.—The total length of the body is 4½ to 4¾ times the length of the head.

The length of the head is 3⅔ to 4 times the diameter of the eye. Day places the proportion at over 4 times.

The length of the snout is ⅔ to once the diameter of the eye.

The length of the head, the height of the body and the length of the caudal fin are about the same, but the first is usually a trifle greater than the others.

The least depth of the tail is equal to the length of the postorbital part of the head, i.e., rather more than ½ the total length of the head.

The length of the pectoral fin is nearly equal to the length of the head, viz., from the posterior border of the head to halfway along the snout.

The first spine of the first dorsal fin is the same length as the postorbital part of the head.

The third spine of the anal fin is about ⅓, or somewhat more, of the length of the head.

Colour.—The living fish shews the following colour characters: The upper half of the pectoral fin is black, and the lower half grey to pale; the first dorsal fin is mostly black, with a paler base; the second dorsal fin has a yellow coloured base, the rest being black; the caudal fin is yellow with a dark edge; the anal fin and the pelvic fin are orange coloured with black tips. The dark lines along the scales are prominent in the adult, but less marked in the young. Preserved specimens lose most of their colour except the black.

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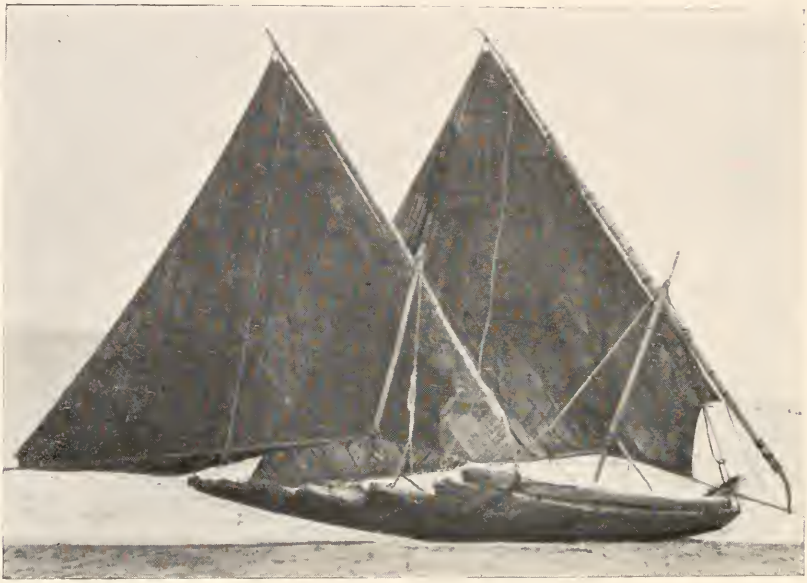

FIG. I.—TWO-MASTED KOLAMARAM (NEGAPATAM).

FIG. II.—KOLAMARAM MAKING READY TO BEGIN FISHING.
(Photographed by J. Hornell.)

Report No. 4 of 1922

THE FLYING-FISH FISHERY OF THE COROMANDEL COAST

AND

THE SPAWNING HABITS OF CYPSILURUS

WITH 4 ILLUSTRATIONS

BY

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So long ago as 1908 I published in volume IV of this Department's Bulletin a short account of the curious method in use by the catamaran fishermen of the Coromandel coast for the capture of the smaller of the two species of flying-fishes common in the western waters of the Bay of Bengal. The particulars given were based upon descriptions supplied by fishermen; the general facts were believed to be correct, but obviously it was desirable to verify their statements by direct observations—notably so in regard to details and to the reason which influences the fishes to congregate around the lures used by the fishermen.

An opportunity did not offer till July of this year, when it was found possible to utilize the fishery inspection vessel, the *Lady Nicholson*, for the enquiry.

The range of the fishery is co-terminous with the true Coromandel coast—the seaboard of the old Chola Kingdom—extending from Point Calimere in the south, to Madras in the north. Tamil fishermen alone pursue this industry, which must be of very ancient origin as the catamarans employed specially for its prosecution are extremely specialized in every feature, making them, within their limitations, wonderfully suitable craft for their particular purpose.

The season in the south runs generally from the end of May till the middle of July. The chief controlling factor in lengthening the season beyond this period is delay in the arrival of the summer rains and of the consequent river floods. The latter, particularly in the south (Tanjore district) where the Cauvery and Coleroon open to the sea, bring down such enormous volumes of silt-laden water, that when the monsoon floods come, the sea for many miles from shore becomes discoloured with reddish mud in suspension; this the fishermen aver ends their fishing season, as flying-fish never enter muddy or discoloured water. As the river floods north of Tanjore are far less in volume than those of that district and come usually later, the flying-fish fishery in the north extends generally some weeks later. In the neighbourhood of Cuddalore, it usually lasts to the middle of August, and off Madras, in years when the rains are greatly delayed, it may even extend into September.

This year (1922) the Tanjore fishery began on 22nd May and the end came somewhat earlier than usual, on the very day our inspection was made—15th July, in consequence of a spell of continuous bad weather characterized by high winds and overcast skies, during which catches were unremunerative.

Two species of flying-fishes are recognized by the fishermen, a larger called distinctively *Thai-kola* (" Mother-kola ") and a smaller one, usually called simply *Kola*. The former has spotted pectorals and is *Cypsilurus poecilopterus* (C. and V.). It is caught on hand-lines. The smaller species, which runs generally 8 to 9 inches in extreme length, is also a *Cypsilurus*; the species remains to be identified. Sometimes both may be called *Paravai-kola* or *Paravai-min* (= flying-kola or flying-fish), but generally *Kola* alone is used, and this often leads to misunderstanding for *Kola* is also used generally as the name for the half-beaks (*Hemirhamphus* spp.). The popular belief is that *Cypsilurus poecilopterus* is the male and the smaller species the female.

DESCRIPTION OF THE CATAMARANS USED.

As above mentioned, the catamarans (*Kolamaram*) employed in this fishery are greatly specialized. They are indeed the highest development of the catamaran form on the Indian coast. They are designed and built solely for this particular fishery and as they have to go comparatively far into the sea—up to 25 miles

from land—and have to be prepared to meet stormy weather and to stay at sea up to three days if need compels, they are made of unusually large size. The one which we towed to the fishing ground, was said to be of medium size only. The principal dimensions were—

Length over all	33 feet.
Width at the aft lashing	7 ,,
,, ,, fore lashing	4 ,,
Larger sail yard	29 ,,
Smaller ,, ,, ...	21½ ,,
Steering oar (length)	12 ,,
Two Leeboards, respectively	10½ and 9 feet.

The hull of these catamarans is invariably made of seven main timbers with an accessory one lashed on the starboard side, upon which men squat when scooping up the fish. Each timber is specially shaped and these being narrowed at the fore end give a cuneate form to the craft, completed by the addition of an elegant up-turned prow of five pointed members, dovetailed into the forward ends of the seven main logs, to which they are simply but securely lashed. The craft has carefully worked out proportions, elegantly concave above and with fine lines for skimming over the water—the draft being about one foot when loaded. But though of such shallow draft and without keel, it is able to beat against the wind very well indeed; when this is necessary two powerful leeboards are brought into action, one abreast the forward mast (they usually carry two masts), the other at the stern, nearly abreast of the steering paddle, which is itself also an efficient leeboard and of similar shape. Indeed when close hauled, we may justly say that the craft is carrying three leeboards—a curious and perhaps significant fact seeing that the great catamarans of Formosa also employ the same number.

The dugout as used in Malabar cannot compete with these Coromandel catamarans in seaworthiness and, being unable to beat to windward, is comparatively useless for offshore fishing. This accounts in the main for the failure that attended the recent attempt to introduce these boats upon the east coast where stormy weather is more frequent and strong offshore winds prevalent in the south-west monsoon.

The masts of the catamarans are short, and stepped laterally in the *outside* log on the leeward side. The fore mast is well forward

and is the longer. The sails may be classed as lateen; probably the typical lateen was evolved from sails such as these. The head of the sail is lashed to a long yard ending forward in a peculiarly curved heel-piece. A boom is used, but extends only along the after portion of the foot of the sail; a stout rope runs along the forward part—a device intended to permit the foot of the sail to bend angularly at the point it meets the mast, on certain courses. The fore angle of the sail is cut off, giving a short luff. The sail is suspended from the mast head by a doubled grommet. Reefing can be practised in stormy weather by rolling the lower part of the sail upon the boom; the head of the sail can also be lowered in some degree, as a series of notches are cut for some distance down from the mast head, and the yard grommet and stays can be lowered to rest in any of these. The masts are provided with one fore and one back stay and the sails have each a sheet and a yard guy. Seven men constitute the crew.

Besides what has been mentioned the equipment consists of—

Four short catamaran paddles (*tilāvū*) thin, blade-like and slightly curved; a beaded edge along one margin gives purchase for a secure grip;

Three rowing oars, each with a long cuneate blade tied to a pole shaft;

A wooden anchor, one-fluked, with a stone attached crosswise at the other end to form a stock;

Two dip-nets (*kachā*) made by lashing a rectangular piece of netting between two parallel poles, each 7 feet long. The net is 5½ feet between the poles and the length is 4 feet 8 inches;

Three bundles (*kambi*) of leaves, of which one is composed usually of branches of the screw-pine (*Pandanus odoratissimus*), and the others of the little leguminose shrub called *kāvālai* (*Tephrosia purpurea*) growing often abundantly in waste places. Sometimes the branches of the neem (*Melia azadirachta*) are used if *kāvālai* is not readily procurable. Besides these are several coils of coir rope, some light wood floats, empty baskets for the fish, a large chatty of drinking water and a bundle of boiled rice. A peculiarly narrow scoop-like bailer, used to dash water upon the sails, completes the equipment.

METHOD OF FISHING.

The fishermen who take part in this fishery set out in the early morning, usually before daylight, in order to reach the fishing ground by 9 or 10 a.m. The hour of departure varies necessarily with the strength of the offshore wind, and the nearest point at which the shoals approach the coast at any particular locality. The latter depends principally upon the distance at which "black water"—the *kala pani* of Hindustani-speaking lascars—is first found. And this in turn depends upon depth; whether the sea bottom in the neighbourhood slopes gently or steeply downwards. On the day we went out favourable conditions were reached at 12 nautical miles east of Negapatam, the water deep indigo in colour, clear and free from sediment in suspension. The depth was 23 fathoms. The fishermen whose catamaran we had towed out asked to be set adrift as they had already sighted flying-fish swimming in shoals, but not emerging from the water. It was now 8-40 a.m. Soon after numerous other two-masted catamarans came up and while most went further seawards than our position, several dropped sail and started fishing close by. These catamarans were part of the large fleet we had seen already some distance seawards when we left our anchorage at 6-25 a.m.

The preparations are simple. Sails are furled by rolling round the booms, the masts are unstepped and all disposed neatly amidships, the fore end of the longer yard resting on the prow, where the single-fluked wooden anchor is also kept.

The catamaran is now drifting broadside to the wind, the starboard side, on which is the accessory log, being to windward. From this side the men now cast loose three large bundles of leaves, each at the extremity of a long coir rope. These are of unequal length. In the catamaran fishing close to the ship, one rope was approximately 50 fathoms long, the second 30 fathoms, and the third only 10 fathoms. One bundle, that attached to the longest rope, consisted of a branch of screw-pine, the others were of the little leguminose shrub, *Tephrosia purpurea* (*Kāvālai*, Tamil). Each bundle is supported by a small float of light wood, but in such a way that neither it nor the bundle of leaves projects above the surface of the water. The catamaran on the other hand together with its crew, does offer some resistance to the wind and so drifts more

quickly than the leaf bundles, thus ensuring that they stream away from the catamaran on the windward side. My former statement that the bundles were put out on the leeward side is therefore incorrect; neither is any anchor-stone thrown overboard to retard the drift of the catamaran.

After adjusting their lures, the men patiently await the gathering of the flying-fish around the leaf bundles. If they are plentiful, they haul early and capture what fish have come; with good luck they may fill their catamaran within a couple of hours. On the day we were out, the fish were scarce, possibly on account of the long spell of bad weather that had prevailed till the previous day; the men could do nothing but wait and pass their time resting, sleeping, or fishing with hand lines, whereof a supply had been brought.

When fishes are seen to have gathered in quantity round any bundle, it is pulled very cautiously toward the catamaran with every precaution not to scare away the fishes. Two couples of men squat ready on the accessory log, each couple with a dip-net ready between them; one man holds the pole attached to one side of the net, his companion the other. The bundle is hauled in so that it comes alongside between the two sets of dip-nets; if fish be plentiful the two nets are brought into play and the fish scooped out swiftly and quietly. The fore end of each net is dipped almost vertically into the water, brought up under the fish and then, being raised quickly, the fish slide down the middle of the net into the catamaran where the three other men cram them as quickly as possible into big palm-leaf bags. The reason for the peculiar form, and large dimensions of the dip-nets is now obvious, as well as that for the accepted number of seven making up the crew, namely, three men to tend the three lures and store away the fishes, and four men to man the dip-nets.

Our men stated that they saw 40 or 50 flying-fishes round the bundles, but unfortunately when they hauled them in they were able to capture only a single fish, a ripe male as it subsequently proved to be. Its length was 7⅞ inches over all.

THE SPAWNING HABITS OF FLYING-FISHES.

The bundles of leaves, which had been streamed out for six hours, were brought on board and one of the Kāvālai bundles gave us the key to the real reason why these flying-fishes congregate around these bundles. It is not, as formerly believed, to obtain shade and shelter; it is to find a place suitable for the deposit of their spawn. The proof was plain; the branches and leaves of the shrub were full of a tangled-up multitude of tiny colourless eggs with innumerable glassy threads, tough and elastic, attaching them in masses to one another and also to the leaves and branches of the plant. The eggs were devoid of colour, transparent save at one pole, where a tiny opaque white disc, the blastoderm area, was distinguishable. All as it proved subsequently had been fertilized. My assistant, Mr. Ramaswami Nayudu, kept similar eggs alive for over 24 hours and was able to watch the early development of the embryo, which will be described by him in a separate note. The filaments attached to the eggs are sometimes surprisingly long and highly elastic, and admirably adapted to tangle the eggs securely among the leaflets of floating seaweed (Sargasso-weed chiefly) which is undoubtedly the natural object for the purpose. The diameter of each egg is from 1·6 to 1·8 mm.

I was informed but could not verify the statement that the fishermen sometimes detach these eggs, crush them and throw the resultant mass back into the sea; this is said to attract further numbers of flying-fish which eagerly devour this form of ground bait.

This statement of the fishermen is confirmed by the fact that on a previous occasion (29th July 1919) the stomach of a spent female brought ashore at Madras by the crew of a fishing catamaran, contained nothing but a mass of eggs with thread-like entanglements, such as we now know to belong to this species of flying-fish. Whether they devour their eggs under normal conditions, say after having finished spawning, or only when broken up and thrown out as ground-bait by fishermen, has yet to be determined.

By three o'clock in the afternoon when fishing was suspended, the catamaran had drifted to a point 22 miles to the north-east of Negapatam, and into a depth of 30 fathoms, a northerly drift approximately of 1½ mile per hour.

During the time fishing operations were in progress, numerous hauls of plankton were made from the inspection vessel at various depths. The results showed the dominant organisms throughout to be *Salpa* and *Doliolum*. These were present in vast abundance. All were small, the salps chiefly in double chains with individuals of all sizes up to half an inch in length. Siphonophores were common, *Diphyes* being the most abundant. Several species of Medusoids were represented but none in quantity. Molluscs were represented by numerous small stout Pteropods (*Hyalea* sp.) and by *Atlanta* larvæ also comparatively frequent. Crustaceans were notably very scarce, almost entirely Copepods of medium size. Pelagic annelids were fairly common. Of fish larvæ only a single individual was seen. Numerous colonies of *Collozoum* were the only protozoa noticed. Sargasso-weed, which presumably is the usual object upon which this particular species of flying-fish deposits its eggs, was scarce, only a single piece being noticed the whole time we were at sea. This absence may possibly be correlated with the proved scarcity of flying-fishes.

So far as I can ascertain, this is the first occasion on which definite and first-hand information has been obtained relative to the characteristic spawning habits of any species of flying-fish. The only reference I can find to the subject is Evermann and Radcliffe's quotation* under *Exocoetus volitans* (L.) of a note by Dr. Coker on some fish eggs as follows:—

"Eggs were purchased in the market of Arequipa, July 26, 1908. They constitute a common market article known as '*cau-cau*.' According to the fishermen of Mollendo, they are the eggs of the flying-fish 'volador' and are found abundantly in the early summer beginning with October. Large quantities are dried for later use." As *pez volador* is the local name for *Exocoetus chilensis* (Abbot), which is a synonym of *E. volitans*, Evermann and Radcliffe infer that these egg masses probably belong to this species. No information is forthcoming as to the conditions under which these egg masses are deposited; from what we have now learned concerning the spawning habits of one Indian species, it seems likely that *E. volitans* follows the same practice; if so we may infer that it is probable that the same habit is common to all flying-fishes.

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* "The Fishes of the West Coast of Peru and the Titicaca Basin," *U.S. Nat. Museum Bulletin*, No. 95, page 44.

Some species of the closely allied genus *Belone* appear to have the same habit, for Mr. Ramaswami Nayudu has shown me eggs attached by long and slender filaments to a small feather which the fisherman who brought them stated belonged to a fish of this genus* ; Day records also eggs of *Belone* having been found attached to the meshes of a mackerel net in the south of England.

DESCRIPTION OF THE NEGAPATAM SPECIMEN.

It is unfortunate that the only occasion when I had an opportunity to see this fishery in operation off the Indian coast coincided with a dearth of fish ; the other catamarans were equally unsuccessful with ourselves, so the fishermen, having had no catches for the previous week or more, considered the season at an end, and the fishery closed. Hence no opportunity offered to get further specimens. The single fish caught belongs to the smaller of the two species of flying-fishes best known to the fishermen of the Coromandel coast. The other and larger is the fine *Cypsilurus poecilopterus* (Cuvier and Valenciennes) easily recognized by the many dark spots on the pectoral fins. The smaller species where the pectorals in life are dark purple in tint with a narrow hyaline margin above and a wider one below, has not yet been identified. It does not appear to belong to any of the species of *Exocoetidae* described by Day† or by Weber and De Beaufort‡.

The fin formula of the individual obtained at Negapatam is—

D. 11 ; A. 11 ; P. 15 ; V. 6 ; C. 17.

Its length was 7⅞ inches (200 mm.), inclusive of the caudal fin.

Subsequently I obtained particulars of five other adult individuals caught off Madras in the months of July and August in previous years. They measured in length, respectively, 9·5, 8, 7·5, 8 and 8·2 inches over all. Considerable variation was shown in the number of the dorsal rays, these being 11, 9, 10, 10 and 12, respectively. Curiously enough the largest individual had only seven rays in the anal fin—probably an abnormality ; of the others three had 11 rays and one 12. Four had 15 rays in the pectoral, the fifth having 16 ; the ventral had 6 in all instances.

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* The mass of eggs was attached when found to a piece of floating wood ; the feather was merely entangled with some of the eggs.

† *The Fishes of India*, London, 1878–88.

‡ *The Fishes of the Indo-Australian Archipelago*, Vol. IV, Leiden, 1922.

The fin-formula as deduced from the above would be—

D. 9–12; A. 11–12; P. 15–16; V. 6; C. 17.

The scales along the lateral line of those examined varied between 42 and 44, while the transverse rows below the anterior end of the dorsal fin were six above and two below the lateral line. Head in total length 5¼; height in total length 6¼; eye in head 3.

The pectoral fin is long, reaching nearly or quite to the posterior tip of the anal fin. The ventral reaches to some distance posterior to the commencement of the anal fin; this may vary from a point one-quarter to two-thirds the length of the anal fin from its anterior end. The lower caudal lobe is one-half longer than the upper.

The colouring of the body in life is deep blue above, silvery below. Pectoral purplish with a hyaline margin, that along the posterior edge the wider. Dorsal dusky, owing to the presence of minute dark dots. Ventral similarly dusky in the outer portion (half to three-fourths of the fin). Anal colourless. Caudal dusky.

Should the species prove to be a new one, I propose that it be called *Cypsilurus coromandelensis.*

Fig. III.—Dip-net used in the Flying-fish Fishery.

Fig. IV.—Flying-fish spawn deposited upon a bunch of *Tephrosia purpurea*.

(Photographs by J. Hornell.)

A NOTE ON THE EGGS AND EARLY EMBRYONIC DEVELOPMENT OF CYPSILURUS

BY

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WITH THREE TEXT-FIGURES

The eggs of the species described by Mr. Hornell in the preceding report when laid are of a glassy transparency with a small opaque white germinal disc in each. They are almost spherical, 1·75 to 1·8 mm. in diameter, and are very tough and resilient, rebounding like an indiarubber ball when struck against any hard surface.

They are attached to floating objects and to one another by means of hyaline filaments issuing from the surface of the egg membrane. These filaments are of three kinds; first, one single filament, the stoutest and the longest, which is the egg's main anchoring cable; second, a tuft of 7 to 16 tiny thin short ones exactly at the opposite pole, and third, 4 to 6 medium-sized ones which form side stays. The function of the tuft of tiny filaments is not known as in all the eggs examined they were free and unattached. The egg is very slightly elongated towards the pole from which the stout long filament issues. When the eggs are attached only to one another the main and the side stays are plaited together to form a stout central cord of considerable length, consisting of several thin filaments, from which the eggs project on all sides in the manner of grapes in a bunch in which case the stem of the bunch will represent the stout central cord of the mass of eggs.

The white disc referred to above is composed of a mass of minute cells which go to form the "germinal disc," indicating thereby that these eggs have already been fertilized; the position of the disc in the egg does not seem to be constant. A few minute oil globules are scattered about in the yolk.

I found these eggs for the first time on the 29th July 1919 attached to a bundle of *kāvālai* plant (*Tephrosia purpurea*) brought ashore by a kolamaram catamaran which landed its flying fish catch on the Rāyapuram (Madras) beach that evening.

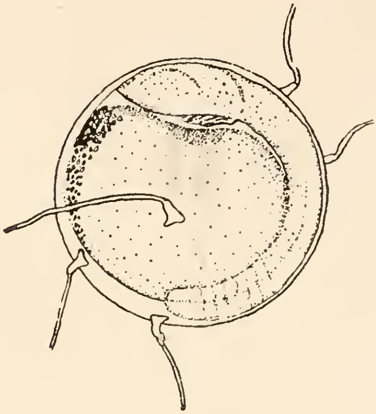
FIG. 1.—Egg of *Cypsilurus* a few hours after fertilization. The dark mass of small cells near the lower side represents the germinal disc. The three forms of filaments are shown, and a few minute oil globules are seen scattered through the yolk. × 20.

The presence of plenty of these eggs in the stomach of one flying-fish dissected the same day is significant in view of the statement of the fisher-folk that, to attract more shoals of flying-fish, they usually detach a quantity of the eggs laid on their *kambi*, then crush and throw the mass into the sea as bait.

On the 15th August 1919, I found at Rāyapuram (Madras) one female specimen with the eggs oozing out and one male partly spent. Again on the 10th July 1920, I collected from Madras three specimens, 7·5″, 8″ and 8·2″ long, respectively, which were all males and were more or less fully mature.

On the 17th July of the present year (1922), I obtained a few eggs from the *kāvālai* bundles of a kolamaram catamaran at Negapatam and these, according to the statement of the crew, were deposited that same afternoon; these were perfectly transparent save for the small white germinal disc. They were kept

FIG. 2.



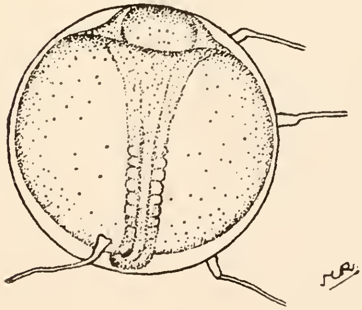


FIG. 3.

FIGS. 2 and 3.—Embryo of *Cypsilurus* about 24 hours old. In figure 2 a lateral view shows the embryo bent partly round the yolk mass, the oil globules congregated into a median streak in front of the head. Figure 3 gives a dorsal view of the same embryo. In both the basal ends of a number of the larger hyaline filaments are shown. × 20.

overnight in a bucket of sea water which was frequently changed. When examined after about 24 hours on the 18th July 1922, a well-developed embryo had been formed in almost all (figures 2 and 3). The eggs had become slightly opaque white and the embryo greyish white in colour. The embryo was bent round the central

yolk to about two-thirds its length, the tip of the tail being slightly twisted towards the left; all the scattered oil globules had congregated into a median streak in front of the head. Already the massive head with the two optic vesicles, the heart, and the myotomes of the body and tail were formed.

It is unfortunate that, for want of proper hatching apparatus, the further development could not be traced.

Report No. 5 of 1922

THE AIMS AND ACHIEVEMENTS OF THE MADRAS DEPARTMENT OF FISHERIES

BY

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Fifteen years having elapsed since the active work of fishery development in its varied branches was commenced in Madras, it is appropriate that an opportunity be now taken to review concisely the work attempted and the successes achieved.

The aims of the department have grown considerably since its inception by the acceptance by Government in 1907 of the first proposals made by Sir F. A. Nicholson, K.C.I.E., the outcome of two years' inquiries in India, Japan, Europe and the United States. Before summarizing the results of our endeavours, a list of the principal aims which we now conceive should be covered by the activities of the department must be given ; they are—

(1) To increase the food-supply of the people by developing both the marine and the fresh-water fisheries of the country to their utmost capacity.

(2) To improve the material and moral conditions of the fisher community by introducing better methods and improved gear, by demonstration to them of the value of thrift, co-operation, education and temperance, and by gradual enlightenment to lead them by degrees to become happier men and better citizens.

(3) To introduce new fishery industries and to develop old ones.

(4) To fight mosquito-borne diseases by the breeding and supply of larvicidal fishes into waters in malarial localities.

(5) To popularize interest in our operations and incidentally in marine and fresh-water biology by means of Public Aquaria, and the publication of popular zoological literature; also to

facilitate the study of zoology throughout India by the provision of zoological specimens suitable for teaching purposes.

(6) To carry on such scientific study of the bionomics of the food-fishes of the Presidency and of the animals on which they feed as our limited means will permit, bearing in mind that our resources must be utilized in the first instance for strictly practical and economic ends.

The practical working out of the above falls under one or other of the following main heads:—Fishery Development, Industries, Technical and Scientific Investigation, Education and Socio-economics.

I.—FISHERY DEVELOPMENT.

The two chief items under this head represent two of the outstanding successes of the department. They are the reorganization of the historic chank fisheries of the East Coast and the stocking schemes whereby our tanks and rivers are made to yield more abundantly. Both are highly profitable directly and these profits in good seasons usually enable a large proportion of the expenses of the department to be met without trenching on public funds. In other words "Fisheries" to a great extent has been a self-supporting department, able to pay its way. With the large and non-productive educational work now initiated, this favourable balance is not likely to be maintained.

The Chank Fisheries are peculiarly profitable. They are old and historic prerogatives of the Crown, worked directly by the Fisheries Department by means of volunteer labour, paid piece-work. The department provides many valuable facilities to the divers free of cost, including towage to the fishing grounds, buoying of the beds, and provision of camping quarters, assistance which considerably increases their earnings and gives them comfort undreamed of in former days. In spite of higher prices paid to the fishermen, the work of the department has resulted in largely increased catches and profits—

	RS.
In 1917–18 these fisheries gave a net profit of ...	39,278
In 1918–19 this rose to	67,580
In 1919–20 to	46,029
A total for these three years of ...	1,52,887

Since the 1919-20 season, owing to unfavourable markets and weather and to transient labour shortage, the profits have been less, viz.—

	RS.
1920-21	36,536
1921-22	8,266

A drastic scheme of retrenchment and reorganization is now being put into operation and already has been successful in overcoming the exceptional difficulties that beset this work during the past two years.

The chank fisheries of Madras are worked off the coasts of the six southern maritime districts on the east coast. The most important are those of Tinnevelly and Rāmnād. The former yields from 1½ to 2 lakhs of shells per annum, the latter, leased for fifteen years for the sum of Rs. 60,000 from the Raja of Rāmnād, usually gives from 2 to 2½ lakhs. The smaller fisheries of Tanjore, South Arcot, Chingleput and Nellore are leased by Government to contractors, who make their own arrangements with the fishermen, subject to certain rules. The two fisheries carried on departmentally are now as fully organized as present conditions permit. Their produce is sold in advance by tender on terms generally extending over three seasons. Fisheries Bulletin No. 7 is devoted to a monograph of the chank. A detailed account of the methods adopted to fish the shells is given; the exceedingly ancient and wonderfully interesting industry of chank bangle manufacture is also described and illustrated very fully, while the ethnological importance of the wealth of curious folklore centring round this sacred shell receives adequate attention.

The Pearl Fishery off the Tinnevelly coast, which is intimately associated with the chank fishery, bulked largely in importance in ancient days. From causes still obscure but probably connected with changes in the contour line of the coast, the pearl banks have been seldom productive in recent years. In common with the Ceylon Pearl Fisheries, no fishery has taken place since 1908, except a small one at Tondi in Palk Bay in 1914. Historical evidence shows that there have been similar long barren intervals in the past, punctuated by an occasional fishery, hence we inspect the banks periodically in order that when the pearl oysters do re-appear, they may be properly watched and fished at the right time. The result of the long continued observations of the

writer shows that there is little or nothing to be done to obviate the recurrence of barren years. Science in this has been proved helpless in the face of the annually recurring monsoon.

The Fresh-water Fisheries administered by the department rank second only to the chank fisheries in regard to the handsome profit they return to Government. They show continuous yearly increase in the revenue obtained and there is every prospect that this satisfactory feature will continue concurrently with the extension of operations. These fisheries consist largely of waters in which the fishing revenues were assigned to district authorities years ago for local needs. The new owners did nothing to effect improvements, the fishery rents being sold for what they would fetch. The Fisheries Department has now initiated a scheme whereby irrigation tanks and other inland waters are surveyed district by district, and those found suitable are arranged in groups round centres where fish-breeding and rearing are carried on, and whence each year fry are removed in large numbers to reinforce the natural stock in the linked tanks. The fishing rights and revenues in these are being re-acquired gradually by Government, compensation being given on the average revenue of the preceding five years to the local authorities, who now have neither trouble nor risk in collecting this money. The profit made by Fisheries is the difference between the compensation thus paid and the revenue obtained from the fish sales after the working expenses of the annual restocking are deducted. The net profits on these inland fisheries during the last three years have been Rs. 20,573, Rs. 21,331 and Rs. 22,613, respectively. Within a short time from now the operations of this section will be enormously increased, for Government have agreed to the whole of the suitable tanks in the Presidency coming under the department's care eventually. In 1920 they approved of a detailed scheme for the organization of the most important tanks in the Nellore and Chingleput districts, whereby 135 tanks have come directly under the control of the department. The tanks of the Ganjām district have recently been surveyed and before long the whole Presidency will be covered and their inland fisheries set upon a suitable basis.

To render successful this fish-stocking of inland waters much patient research and experiment have been necessary; results have suffered from the lack of any estuarine and fresh-water research

station. In spite of this, notable success has been achieved, particularly with the seththakendai (*Etroplus suratensis*) of the Madras neighbourhood, with the large indigenous carp, *Catla catla*, and with certain of the mullets. The life history of the first of these has been worked out in detail, and it is now being bred regularly and in large numbers in all three of our existing fish farms at Perambur, Sunkesula and Ippur. The value of scientific research is well demonstrated in respect of Etroplus; consistent success only resulted when the breeding habits had been ascertained; the secret of success lies in the provision of suitable stone-built breeding refuges where the eggs may be deposited safely in the manner peculiar to this species. This fish is found naturally in estuaries and tanks near the sea-coast. By the efforts of the department it has been acclimatized successfully to waters far inland; Sunkesula is 130 miles from the sea. Similarly with the catla carp. It is numerous in the Kistna, the Gōdāvari and the rivers further north, but till some 50 years ago the Kistna formed the southern limit of the distribution. Since the opening of the Cuddapah-Kurnool canal and the stocking of its reaches by this department with fry of this species, the catla has found its way into the river Pennar and is now very common in the Pennar-fed tanks in the Nellore district. Two years ago it was introduced into the great Madurantakam tank in the Chingleput district and this year large numbers were liberated in the Cauvery thereby extending its range still further south. Further extension will be made when the Chingleput Fort fish-farm is in operation.

Other useful acclimatization centres in the distribution of the fry of certain species of mullet from estuaries to inland waters. This is the most recent of our efforts in this direction. The results are very gratifying for fry ranging in length from 2 to 5½ inches have been found to increase in inland tanks to 9 and 11 inches within a period of 10 months.

The successful stocking of the Nilgiri streams with rainbow trout from New Zealand is another demonstration of what is possible when these operations are skilfully conceived. When these streams were first administered by this department, they were, with the exception of some carp and small minnows, devoid of fish life; now they teem with trout bred at the hatchery at Avalanche.

Sea Fisheries.—The development of our sea fisheries by introducing improved boats and appliances has presented greater

difficulty, largely due to the conservatism of the fisherfolk and the difficulty of getting satisfactory teachers and demonstrators. The introduction of methods proved excellent in one locality, into another where those that are indigenous are weaker in catching power, has been tried in Malabar, Tuticorin, Madras and Negapatam. At none was there decided success, but recently both at Calicut and at Negapatam local men have come forward with proposals to take over the boats and gear we have used for the demonstrations. Supervision of actual operations on the fishing grounds has been hitherto in the hands of intelligent but otherwise uneducated men as no educated Indian fishermen at present are available; the material being faulty and lacking in initiative, it is no wonder the results have been unsatisfactory in the main. Neither have these men been able to report intelligibly upon the conditions of the new waters they have worked in. With the recent placing of an order for an experimental sea-going launch to be devoted to the purpose of introducing and testing new methods, this vitally important problem will be attacked in a fresh direction with greater resources than in the past, and with greater concentration of effort. This fishing launch will be manned by an Indian crew who will be taught under the working direction of an experienced European master-fisherman able to report results and to vary the methods according to circumstances.

II.—INDUSTRIES.

Fish curing is an age-old industry in India, but the methods in use are generally primitive and susceptible of great improvement in regard to the flavour, appearance, cleanliness and keeping quality of the products. The chief indigenous method is to salt the fish, usually for one night, followed by sun-drying. Long and patient endeavour to ascertain improvements in methods that are yet inexpensive to adopt has been made by the department, particularly at its Experimental Station at Tanur in Malabar. Here numerous and varied experiments have been conducted with generally gratifying results. To enable the methods thus elaborated to be introduced to the notice of curers and to improve general conditions, particularly in regard to cleanliness and sanitation, six Government fish-curing yards were transferred temporarily from the Salt Department to "Fisheries" over two years ago. Progress in improvement has been slow owing both to the innate and ignorant conservatism of the curers and to factious opposition.

With patience, these obstacles are being overcome; even now there is a notable improvement in the cleanliness of the products of these yards.

Canning.—Experimental work was begun at Calicut in 1911, and transferred later to Chaliyam, 7 miles to the south. Complete success has been attained on the operative side, the quality of the goods packed being, in the opinion of experts, equal to similar European products. Notably is this the case in regard to the canning of sardines, mackerel and prawns; these constitute the bulk of the goods produced. The Indian oil sardine *(Sardinella longiceps)* at its best, is, in my opinion, fully equal to the true French sardine, which is in reality the young of the pilchard. Its oil content is greater than the latter, and this, I hold, is the chief criterion by which to estimate the value of the sardine for canning purposes.

Oil and guano factories.—Prior to the experimental work of the Fisheries Department in 1908, the amount of sardine oil produced on the West Coast was inconsiderable and of the worst possible quality. The usual method was to obtain the oil by the putrefaction of a mass of sardines contained in a worn out and filthy dug-out canoe. It was also a wasteful process, for the proteid and other residue were thrown into the sea. Similarly when fertilizer was made from sardines, the ancient and accepted procedure was to spread the sardines on the sand of the open beach, and so dry them in the sun. This had two drawbacks—large quantities of valuable oil, of no manurial value, were wasted, and the product became so highly impregnated with sand that analysis not infrequently showed the resultant mass to contain as much as 40 per cent of this useless adulterant.

The experiments made by the department had unexampled and swift success. It was found that a simple and quite inexpensive plant could be devised to separate the oil and fertilizer effectively and profitably. The high quality of the oil and fertilizer ("fish guano" as it is now known technically) reacted favourably upon prices, and has rendered this new industry so profitable that literally hundreds of small factories have come into existence. In this case the demonstrations we were able to give were so conclusive financially, that the small capitalists of the West Coast rushed to share in the big profits that were being made by those first in the field. At the close of the 1919-20 fishery year the

number had reached the amazing total of 563. The estimate of their production for the same season was 24,000 tons of fish-guano valued at Rs. 100 per ton, the value of the oil manufactured being about Rs. 3,75,000—the two together amounting to 27¾ lakhs—a wonderful result, which apart from any other success achieved by the department, would alone justify its existence. A further advance has again been made during the past two years whereby it appears likely that much of the material now used as fertilizer will eventually be utilized more profitably as a feeding stuff for domestic animals. Success has already been obtained in producing high class fish-meals from all the common fishes found plentiful on the West Coast, particularly mackerel and sardines. Those who have tried these meals for cattle, pigs, dogs, and poultry speak highly of them when employed in proper proportions with a greater bulk of starchy foods. It now remains to produce them in larger quantities and to introduce them widely to the notice the Indian public. In Europe and America the high nutritive value of these meals is recognized and the fish-meal trade there is assuming large and important proportions.

Soap making.—This industry has now passed from the control of this department but the credit for its successful inception belongs to "Fisheries." The story is worth repeating. In 1913 an oil expert, Mr. A. K. Menon, trained in England under a Government scholarship, was appointed to this department to investigate under the direction of Sir F. A. Nicholson, the character and uses of sardine oil and fish stearine. His work at the Tanur Experimental Station resulted in the production of a fish-oil soap that is now in great demand by tea, coffee and mango planters as a cheap and efficient insecticide. This success naturally led to the manufacture of other soaps from vegetable oils and other fats. When the industry was thoroughly established, the latter branch of the work so overshadowed the former, that it became an anomaly to carry on the work under the Fisheries Department and so it was transferred to the Department of Industries.

Bêche-de-mer.—This minor industry, which consists of the curing of the thick body wall of a species of sea-cucumber (*Holothurian*), had virtually died out some years ago when this department's attention was drawn to its decay. An investigation was made and experiments carried out as detailed in Report No. 4 of Fisheries Bulletin, Volume XI. It now constitutes an integral section

of the department's operations in Palk Bay and affords a welcome addition to the income of the chank divers of that locality. In 1919–20, the total dried production was 6,245 lb. The whole of this eventually finds its way to Singapore and thence to China.

III.—TECHNICAL AND SCIENTIFIC INVESTIGATION.

Apart from researches directly connected with the industrial branch, investigations covering a wide field, and continuous since the beginning of operations, upon zoological and oceanographic subjects have been carried on to considerable extent. The varied nature of these enquiries will be understood from the list of publications given below:—

By Sir F. A. Nicholson—

1. Note on Fisheries in Japan (Bulletin II), Madras, 1907.
2. The Preservation and Curing of Fish (Bulletin III), Madras, 1909.
3. Carp Growing in Germany (Bulletin XI), Madras, 1917.
4. Remarks on Canning (Bulletin XIII), Madras, 1921.
5. Manufacture of Fish Oil and Guano (Bulletin XIII), Madras, 1921.

By Mr. James Hornell—

Pearl Fisheries.

1. Report on the Indian Pearl Fisheries of the Gulf of Mannar (a long report of 109 pages), Madras, 1905.
2. Explanation of the Irregularly Cyclic Character of the Pearl Fisheries of the Gulf of Mannar (Bulletin VIII), 1916.
3. Report on the Pearl Fishery held at Tondi, 1914 (Bulletin VIII), 1916.
4. Prof. Huxley and the Ceylon Pearl Fishery, with a note on the Cultural Production of Free Spherical Pearls (Bulletin VIII), 1916.

4*a*. Pearl Formation in the Indian Pearl Oyster (*Jnl. and Proc., Asiatic Society of Bengal*, N.S., Volume XVIII, No. 2), 1922.

(Also numerous reports in the 5 volumes of Reports to the Government of Ceylon on the Pearl Fisheries of Ceylon, published by the Royal Society.)

Oyster Culture.

5. Report on the Suitability of Pulicat Lake for Oyster Culture (Bulletin IV), 1908.

6. Note on an attempt to ascertain the Principal Determining Factor in Oyster Spawning in Madras Backwaters (Bulletin IV), 1908.
7. The Practice of Oyster Culture at Arcachon and Its Lessons for India (Bulletin V), 1910.
8. The Present Depletion of the Oyster Beds of Sind ; Its Causes and the Remedies (Report to the Government of Bombay), 1910.
9. A Note on the Edible Oyster (Bulletin VII), 1916.

Chanks and Chank Fishing.

10. The Sacred Chank of India (Bulletin VII), 181 pages, Madras, 1914.
11. The Indian Conch (Turbinella) and Its Relation to Hindu Life and Religion (In *Marine Zoology of Okhamandal*).
12. The Chank Bangle Industry (*Memoirs of the Asiatic Society of Bengal, Volume III*, No. 7, pages 407—448), Calcutta, 1913.
13. The Indian Varieties and Races of the Genus Turbinella (Chank) (*Memoirs of the Indian Museum*, Volume VI), Calcutta, 1916.

Other Mollusca.

14. The Utilization of Coral and Shells for Lime Burning in the Madras Presidency (Bulletin No. VIII), Madras, 1916.
15. The Edible Molluscs of the Madras Presidency (Bulletin XI), Madras, 1916.

15*a*. The Common Molluscs of South India (Bulletin XIV), Madras, 1921.

16. A Revision of the Indian Species of Meretrix (one of the clams) (*Records of the Indian Museum*, Volume XIII, Part III), Calcutta, 1917.
17. The Anatomy of the Window-Pane Oyster (Placuna) (*Marine Zoology of Okhamandal*), London, 1909.

Fishes and Fishing.

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By Mr. S. T. Moses—

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By Mr. M. Ramaswami Nayudu—

1. A Statistical Analysis of an Inshore Fishing Experiment at Madras (Bulletin XII), 1919.
2. The Eggs and Larvæ of Flying-fishes (Bulletin XV), Madras, 1922.

By Mr. Ramaswami Ayyangar—

1. Notes on the Fauna and Fishing Industries of the Laccadive Islands (Bulletin XV), Madras, 1922.

IV.—EDUCATION.

It was early realized that no rapid progress in the general improvement of the conditions of our fisherfolk is possible till their intelligence has been quickened and their comprehension of our recommendations and methods facilitated by education on simple

but practical lines. A comprehensive scheme was therefore drawn out in March 1919. Government approved the proposals and up to the present time the department has opened 18 day and 9 night elementary schools. It is intended to open others as opportunity and funds allow. To provide teachers with qualifications especially adapted for these fisher schools, the department has established a Training Institute at Calicut; 36 stipendiary students are now undergoing training. These pupil teachers in addition to the curriculum followed in an ordinary training school receive specialized instruction in organizing and managing fishermen's co-operative societies, in sanitation, hygiene and first aid, and in the improved methods of fish-curing, manufacture of oil, guano, and meal, and other technical work elaborated at the Tanur Experimental Station. They are also given a practical insight into the chief methods of catching fish. The course extends through three years and by the end of that time it is hoped that the majority will be well on the way to become the Admirable Creightons of the fishing villages where they will be posted.

Education of a different nature is catered for by the existing aquarium at Madras, an institution established by Mr. Edgar Thurston in 1909, and transferred to this department in April 1919. It has been entirely reorganized; electric lighting has been installed and the exhibits enriched and rendered more attractive. An illustrated guide has been issued. The success of the reorganization may best be judged by the attendance, which leapt from 96,957 in the year we took charge, to 163,517 in the succeeding year. Similarly the takings increased from Rs. 3,783 to Rs. 9,772. In spite of a large increase of expenditure upon improvements, the profits are now Rs. 4,778 as against Rs. 1,719. The liberal expenditure on reorganization has therefore fully justified itself. Of the illustrated guide issued at a nominal price of 1 anna, 8,066 have been sold since its first publication in October 1919. This too in spite of the guide being published in English. A vernacular edition in Tamil has also been issued and has sold freely.

But our efforts to popularize the study of the animals of our seas are not limited to this one effort. A Zoological Supply Section was organized over four years ago at Tuticorin (since removed to Ennur) whence specimens of a great range of the inhabitants of our seas and coral reefs are despatched to any teaching institution or museum requiring them. Previous to the initiation of this supply

section, colleges throughout India were compelled to base their practical zoological teaching either upon text-book illustrations or to buy specimens at expensive rates from European Biological Stations. The Madras Fisheries Department has therefore become a Swadeshi organization in the true sense of the word; zoological study in India can in future be based upon locally obtained supplies. In this connexion I wish to draw attention to the fact that this useful work is not limited to the Madras Presidency; indeed the chief customers are colleges in the north of India, hence it is essentially an all-India service that we are rendering.

Our intention is eventually to supply all local school museums with typical sets of properly identified collections of common marine animals to replace the present useless jumble of unnamed specimens that serve no useful purpose, and are but a camouflage device to give school inspectors the idea that the boys take an interest in Natural History. These type collections are accompanied by printed explanatory notes, giving all important and interesting facts touching the specimens.

The value of the specimens sent out during the past three years shows clearly how appreciated by teaching institutions are the facilities thus provided. The figures are as follows :—

		RS.	A.	P.
1917–18	Receipts	755	11	0
1918–19	Do.	1.257	14	6
1919–20	Do.	1,607	12	0
1920–21	Do.	3,131	4	0

V.—SOCIO-ECONOMICS.

This section though always kept steadily in view from the first as ultimately one of the most important to which attention must be given, has been taken up comparatively recently in an extensive form. The staff detailed to its promotion is small and this of itself limits progress. The conservatism and suspicion of the fisherfolk already emphasized is another bar to rapid progress. Hence it is gratifying to record that this department, working in close touch with the Registrar of Co-operative Societies, has been so successful in preparing the ground and in carrying out preliminary arrangements, that the number of fishermen's co-operative societies had risen to 60 at the close of last year, with several further applications pending. The majority of these are thrift

organizations, engaged in loan operations. A notable variation is a wholesale co-operative oil and guano society at Mangalore, composed of factory owners who are combining to bulk their produce and sell it jointly.

Temperance and village betterment.—A propaganda in favour of temperance is another of the department's activities and this is meeting with a decided and gratifying measure of success in several important localities. This is the case particularly in South Kanara. Such work goes hand in hand with efforts to provide village meeting halls to be used for reading and other recreation. In several instances the fisherfolk have been so impressed with the advantage of possessing such halls, that they have subscribed substantial sums to construct the buildings; the Government provide the sites free of cost. Every opportunity is taken to show the fisherfolk the advantage of simple methods of sanitation and much is being accomplished in a quiet way.

VI.—ANTI-MALARIAL OPERATIONS.

These form a considerable and very valuable part of our work and consist of three separate phases, viz.—

(*a*) The breeding and distribution of mosquito-larvicidal fishes to municipalities and other bodies.

(*b*) The periodical stocking of pools in specially malarious localities with such larvicides.

(*c*) The conversion of mosquito-infested sheets of water into fish-breeding ponds which also serve the purpose of fry distribution centres for the stocking of irrigation tanks.

(*a*) The department is able to supply large numbers of larvicides at the nominal cost of Rs. 10 per thousand, but in spite of the earnest recommendation of Government, municipalities and other local authorities do not as yet avail themselves at all adequately of the facilities offered them to obtain a good strain of these useful little fishes. They appear either careless of the value of this cheap means of combating malaria, or else depend upon local supplies of what are too often species of inferior larvicidal quality.

The second form of operation is more directly in our power to organize, and an excellent beginning was made last year, when from our larvicidal fish farm at Praema in Kurnool district, 70,000 larvicidal fish were distributed to the streams and pools in the

intensely malarious Nandya and Chelama forest ranges on the Nallamalais. Operations will be extended to other ranges next season.

Our third line of attack upon malarious waters is perhaps even more important. Two instances where operations are in progress, are the conversion of the fort moats at Chingleput and Vellore into fish-farms. In both cases, until these operations were commenced, these moats formed stagnant pools, overgrown with dense pond vegetation, supremely suitable as harbourage to mosquito larvae. As a consequence, malaria was endemic within both forts, an extremely serious condition seeing that a large reformatory for boys is located within the Chingleput Fort, whilst a Police Training School is similarly located within that of Vellore. The cost of the two schemes is estimated at Rs. 11,450 and Rs. 16,000, respectively. When completed, the moats will cease to harbour mosquito larvae and will concurrently become ideal fish-breeding farms, whence large supplies of fry will be available for the stocking of the many large tanks now under the control of this department in Chingleput and Nellore districts.

VII.—STAFF AND COST OF THE DEPARTMENT.

This note, which is intended to take account only of the major operations, will not be complete without a few brief statistics. For the importance of its duties the staff is small. It consists of a Director, 2 Assistant Directors, a Superintendent of Pearl and Chank Fisheries, a Personal Assistant to the Director, 9 Sub-Assistants and a further subordinate staff of 44 exclusive of peons and temporary hands and the crews of the small fleet operated by the department.

As before mentioned the revenue of the department nearly balances expenditure. The figures for the past four years are as follows :—

	Revenue.			Expenditure.		
	RS.	A.	P.	RS.	A.	P.
1917–18 ...	2,26,230	2	5	2,20,049	7	2
1918–19 ...	2,77,145	0	11	2,35,118	12	11
1919–20 ...	2,26,874	2	2	2,45,960	15	8
1920–21 ...	2,29,419	9	4	2,93,026	12	2
	9,59,668	14	10	9,94,155	15	11

That the department after paying all expenses of supervision and a large non-productive outlay for educational purposes should show an adverse balance of not more than Rs. 34,487, over these four years is a record of which it is justifiably proud. The official publication of the department is its "Bulletin." The seventeenth volume is now under issue, the first two constituent reports being in the press. The aim of the department is to record its experiments and results as fully as possible, that those interested may be able to utilize the facts ascertained with as little delay as possible. As will be seen from the list given above the range of subject matter is varied and extensive and has not been confined to purely technical subjects.

MADRAS,
4th Nov. 1922.

Report No. 6 of 1922

A STATISTICAL ACCOUNT

OF THE

FISH SUPPLY OF MADRAS

BY

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In India information regarding fish supplies is very meagre. In the case of salt fish, "the sheet-anchor of the poor," the fish-curing yard returns take cognizance of all that is cured in the yards, omitting private produce. But as regards fresh fish no complete account is on record though short and casual references are found in the Gazetteers and census reports. These remarks hold good for the Madras Presidency also, except for the existence of two reports issued by the Fisheries Department. The following report based on the statistics of fish supplies coming into the Madras markets collected at the instance of the Hon'ble the Minister for Development, for one year, is an attempt to do for Madras what "A statistical analysis of the fishing industry of Tuticorin (South India)" by Mr. James Hornell (Report No. 3, 1917), Madras Fisheries Bulletin, Volume XI, pages 67—117); has done for Tuticorin. No such information has been compiled before now, though Report No. 3 (1920), Madras Fisheries Bulletin, Volume XII, pages 115—133, in which Mr. Ramaswami Nayudu deals with the results of the Inshore Fishing Experiments, gives an insight into the constitution of the food-fish fauna of Madras. The detailed information in the present report giving the extent of the sources of fish supply in Madras will, it is hoped, be of use to all interested in the development of our fisheries and their exploitation by the introduction of more powerful fishing gear and up-to-date fishing methods.

The period for which statistics were compiled was one year and fifteen days. The extension of fifteen days was considered necessary as the work of the first fifteen days (July 1—15, 1921), when the staff were gaining experience, was considered unsatisfactory and this sanction for extension was received in G.O. Mis. No. 322, Development, dated 7th March 1922.

The method employed to collect the statistics was different from the one adopted at Tuticorin. Deputing men to attend at the main fish-landing places to ascertain the catch of each fishing catamaran as it was landed and sold, was not possible on the Madras beach as, unlike Tuticorin, there are many landing places. The seaboard being longer, such a method involving the employment of a staff much larger than the two men employed at Tuticorin could not be adopted. Further, Madras, even if the Cooum and tank fish are omitted, receives seafish not only from the Madras waters but also from Ennore, Pulicat and Covelong wherefrom they are brought by boat, by rail, by jutka or as head loads. Therefore it was considered better for the enumerators to work in the markets where nearly all the fish, except for a negligible quantity disposed off straightway to consumers at the landing places, is exposed for sale.

This work of collecting data from the twenty-one markets of Madras where fish is sold was carried on under difficult circumstances. What with the inadequacy of the staff engaged—two men from other sections were deputed to help the sanctioned staff of one peon and one clerk and each of them had to visit five or six markets twice in a day—the reluctance of the timid fisherwomen to allow our men to gauge the quantity and price of their fish and the labour troubles and political "hartals" in the lccalities of some of the important markets, the enumerators' duties were very trying. One of the men, the clerk, while doing duty at the Paracheri kadai market, was, on the 13th January 1922, the day of arrival in Madras of His Royal Highness the Prince of Wales, very severely handled by the mob who relieved him of his notebook containing the data for over a month; the book, however, was recovered some minutes after the departure of the mob from a gutter close by and fortunately only a few pages were torn and those not completely.

The weight of large fish was calculated by weighing a sample specimen with a spring balance and multiplying its weight by the number of fish counted. As the men became more and more

proficient the actual weighment was given up. In the case of smaller fish the number of baskets was counted and the baskets used reduced in terms of standard baskets of known weight.

As in the case of Tuticorin statistics these figures lay no claim to strict accuracy. But there is no doubt that they can be relied on for purposes of generalization regarding the maximal and minimal seasons, the variations in the catches, the relative abundance of fishes, etc. The total weights and values of the various kinds of fishes consumed in Madras during one year from the 16th July 1921 to the 15th July 1922 are as follows :—

Names.	Weight.	Value.	
	LB.	RS.	A.
Prawns	678,654	91,118	7
Crabs	338,584	40,243	15
Silverbellies (Gerridae)	263,333	29,221	8
Ribbon fish	260,907	26,139	1
Horsemackerel	238,655	34,793	14
(Lactarius)	175,225	24,473	0
Jew fishes (Sciaenidae)	147,152	25,659	4
Anchovies	146,560	17,976	11
Sardines	138,971	17,585	14
Indian herrings	121,816	16,655	4
Grey mullets	120,700	19,817	7
Sharks	105,944	22,196	2
Garfish	77,236	9,777	11
Sea-perches	75,118	11,249	12
Cat-fish	73,123	10,646	13
Mackerel	66,719	9,598	9
Red mullet	58,196	8,596	9
Pomfret	49,072	15,337	7
Seer	42,207	13,660	8
Shrimps	33,004	3,694	8
Dorab	30,865	4,475	8
Indian Whiting (Sillago)	30,719	4,607	9
Cock-up (Lates)	21,511	5,624	12
Indian salmon (Polynemidae)	18,071	3,193	11
Carps	17,018	3,889	5
Gobies	9,133	1,255	14
Queen fish (Chorinemus)	8,510	2,104	7
Rays	7,758	1,701	4

Names.	Weight. LB.	Value. RS.	A
Barracuda	6,220	1,209	7
Soles	6,188	915	1
Murrel	3,875	764	5
Seabream	2,134	383	5
Sandeels	1,692	389	4
Butterfish	1,290	422	6
Freshwater shark	1 283	184	12
Bonito	1,254	310	4
Lizard-fish	469	123	12
(Megalops)	449	48	11
Squid, etc.	438	62	4
Spade-fish	413	71	2
(Teuthis)	377	48	13
Batfish	250	20	0
Sandbugs (Hippa)	145	13	12
Eels	119	33	7
Plough-fish	75	6	0
Crocodile-fish	45	10	6
Surgeon	44	20	12
Gally-wasp	40	6	12
Puffer	30	2	0
(Opisthopterus)	25	3	6
(Chatoessus)	10	2	0
Bombay duck	10	2	8
Hilsa	2	0	9
Miscellaneous	670,262	86,112	7
Total ...	4,054,900	5,66,466	15

As the statistics are based on information gathered from the markets, a few remarks on the fishing gear of Madras may not be out of place. All small fish and some large fish are netted, while large ones are caught with hand lines. The nets in use in the sea are Thuri valai, Eda valai, Mada valai, Peranda valai, Eru valai, Kola valai, Irukkan valai, Vala valai, Kanna valai and Peru valai. In the use of hand lines and the nets except Peru valai the catamarans or keelless rafts made of three to five logs of wood roped together are associated. On the surfbeaten coast of Madras, only such a type of craft can be of use. It is so very simple and can be

taken to pieces so quickly and the component parts so easily beached. It can get through the fiercest surf; a common sight is of the men, washed away from their catamaran by a huge wave, slipping under the wave and picking the raft up on the other side.

The Thuri valai is a light trawl net operated from two catamarans, one of four logs and the other of three, when the current is strong. The net, a conical bag into which two wings lead, is used all the year round whenever weather conditions are favourable. Most of the seafish sold in Madras are captured in this net.

The Eda valai is a square net with two long and two short ropes at the corners. The corners from which the two long ropes emanate carry weights, while there is a float between the two short ropes. The net is operated with four catamarans, two large and two small. When shoals of fish are sighted the four catamarans separate, each with a rope, the net having been let down obliquely. At the opportune moment the net is quickly lifted up by all the four corners, the catamarans coming close together simultaneously.

Sometimes a crude weight—a leaf basket loaded with clay—is let down to the sea bottom by a coir rope with a float at the other end and a string of coconut leaves between. Fish attracted by this are caught by the Mada valai, a net similar in structure and in its mode of operation to the Eda valai, which is swept on the coir rope, the side of the net with the float being carried high up behind. Fish thus caught are usually sardines, mackerel and also large mullets.

Peranda valai, similar to Eda valai but with medium-sized mesh, is also operated from four catamarans. Sardines and small mullets are usually caught.

Eru valai is a very minute-meshed net used with two catamarans for catching shrimps and anchovies.

Kola valai is another net used with two catamarans. It is a kind of Vangu valai with about 100 sticks and is used for catching garfish.

Irukkan valai is a drift net consisting of walls of nets, the under rope of which is weighted while the head rope is buoyed to float on the surface. The net is left in position in the sea for a night and the men go next day to transfer into their baskets the fish which have been enmeshed by gilling. The Irukkan valai is large meshed and is used to capture large seer, sharks, etc. The Vala valai, another drift net but smaller meshed than the former,

is used to capture seer, pomfrets, sharks, hilsa and other shoals of large fish. Kanna valai is another large meshed drift net.

Peru valai is the shore seine used on the Madras coast. For shooting the net in the sea, the masula, a narrow keeled sewn boat, is used. Men working at the two ends of the shore seine who are separated from each other at first by over a quarter of a mile, approach one another dragging the net gradually and evenly from both sides. When the coir portion "Mottal" and the small meshed portion the "Mayila valai" are dragged ashore the fishes enclosed are frightened and rush into the finely meshed bunt. The shore seine is used from about February to June when the surf is not fierce. The fish caught are the silver-bellies, ribbon fishes, anchovies, etc.

The special catamaran used in Kola (flying fish) fishery has been described in detail in Report No. 4 of the present bulletin. The hand net, Kacha valai, is used in tanks and the Cooum. In estuaries, tanks and also on the beach is used a small meshed casting net leaded heavily along the periphery, called Mani valai or Visiri valai, the user wading into knee-deep water. Konda valai, a kind of Vangu valai, with twenty-one sticks is used in tanks. In estuaries, Siru valai with two side ropes carrying coconut leaves is worked by over ten men who keep the mouth of the net open by holding over their heads sticks attached to the top of the net, when the terrorized fish dart into the bag. Once the fish are in, the mouth is closed.

Lining is carried on extensively from catamarans called "Mela Maram" which go long distances to about 20—30 fathoms. The bait used is *Hippa* the sand bug, cuttle fish, squid or octopus, crab, prawn, fish, e.g., anchovy (whitebait), ribbon fish, sardine, in fact any fish. The line fishermen on their way to the fishing grounds purchase their bait from the Thuri valai fishermen. Live bait is also used. Last season, a fisherman tells me, induced by the success of one in lining for seer with live puffers (Tetrodon spp.) most line fishermen used them with deadly effect. The usual bait for seer is the Ribbon fish or any species of *Lutianus* (Nethiprion and Vekkattai).

Lining is also done from the shore both on the beach and in the backwaters. *Polynemus*, the Indian salmon, is usually got though the whiting is also hooked in the backwaters. The bait used usually is *Hippa*, prawn or an Eunicid worm.

In the commercial world fish are divided into prime for the rich and the offal for the poor and here the fish supply being a poor man's question the condition of the industry depends largely on the offal and not on the prime. Out of the 53 different kinds of fish considered edible by Indians only a few such as seer, pomfret, hilsa, some of the horse mackerels, cock-up, bonito and Indian salmon are regarded as prime quality.

The prices of the catches of fish depend upon the time when they are landed and marketed, the condition of the fish—many prefer tainted fish, but thanks to the sanitary supervision of markets such indulgences are scarcer now—and the general abundance or scarcity of fish. On festivals when there is a greater demand than ordinarily the prices run high but on fast days, e.g., Amavasai, Kirthigai, Ekadasi (monthly), Sivarathri (monthly), Saturdays (or Fridays when some Hindu women fast) when the fish-eating Hindus eschew fish, they are very cheap. The prices given in the statistics are those at which the sellers had taken the fish from the middlemen or as in some cases from the fishermen direct and so are cheaper than those usually paid by the consumer in the market.

The average rates per pound of the food fishes of Madras are as follows:—

Names.	A.	P.
Surgeon	7	6
Eels	5	6
Butterfish	5	3
Seer	5	2
Pomfret	5	0
Hilsa	4	6
Cock-up	4	2
Lizard fish	4	2
Queen fish, Bonito, Bombay duck	4	0
Crocodile-fish, Sand eel	3	8
Carp	3	7
Rays	3	6
Sharks	3	4
Murrel (Chatoessus)	3	2

Names.	A.	P.
Barracuda	3	1
Seabream	2	10
Indian salmon	2	10
Jew fish, Spade fish	2	9
Gallywasp	2	8
Grey mullet	2	7
Seaperch, Red mullet, Whiting	2	5
Horsemackerel, Cat-fish, Sole, Freshwater shark	2	4
Prawns (Lactarius), Dorab, Squid, etc.	2	3
Goby (Opisthopterus)	2	2
Indian herring	2	1
Anchovies, Sardines, Garfish (Teuthis)	2	0
Crabs	1	10
Silverbellies, Shrimps (Megalops)	1	9
Ribbon fish	1	7
Sand bugs	1	6
Bat-fish, Plough-fish	1	3
Puffer	1	1

Though fish-eaters, according to eastern writers, are regarded as a contemptible class devoid of understanding—the oft-quoted plea in palliation of ignorance is the offender is only a fish-eater!—fresh fish is considered by medical authorities to be much better than other animal foods. The easy digestibility of well-cooked

fish gives it a superiority over other animal foods. Though held in different degrees of estimation by the various castes, a major portion of the people eat fish whenever it can be procured. The people engaged in fishing and selling fish are mostly Pattanavars (seafishing) and Sembadavar (Nattar) (freshwater and river fishing) and these number 6,714 (4,209 males and 2,505 females). The total value of fish sold during the year being Rs. 5,66,465-15-0, the average income per head per mensem is Rs. 7 only. The poor receipts, though one cannot verify the truth of the plaint of lessened catches, which is unanimous in all kuppams and elsewhere, coupled with the intemperate habits of the people keep them pitiably down as one of the "depressed" classes.

Both in quantity and value the crustaceans are of greater importance than any kind of fish in Madras. The prawns top the list, while the crabs come next. Shrimps, however, occupy a low place. The prawns sold here are both freshwater—*Palaemon carcinus* is the common species—and marine (*Penaeus semisulcatus*). The monthly catches and their value are as follows:—

Months.	Marine prawns.			Freshwater prawns.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	34,369	5,170	1	1,155	189	8	35,524	5,359	9
August	84,754	10,637	13	23,785	3,986	8	88,539	14,624	5
September ...	45,905	6,018	0	29,076	3,471	8	74,981	9,489	8
October	39,683	4,826	2	15,678	1,871	13	55,361	6,697	15
November ...	33,464	3,825	8	7,270	779	9	40,734	4,605	1
December ...	48,364	6,066	12	18,872	2,275	13	67,236	8,342	9
January	40,598	5,909	0	12,360	1,364	4	52,958	7,273	4
February ...	38,229	5,836	1	12,585	1,690	4	50,814	7,526	5
March ...	52,728	6,507	7	11,782	1,384	8	64,510	7,891	15
April	50,453	6,023	1	3,711	580	8	54,161	6,603	9
May	40,599	6,107	4	3,018	420	14	52,617	6,618	2
June .. .	38,332	5,681	14	2,884	404	7	41,216	6,086	5
Total ...	536,478	72,698	15	142,176	18,419	8	678,654	91,118	7

Prawns occupy the sixth place in the list of fishes caught in the inshore fishing experiments of the year 1918-19, while in those of 1917-18 were the second important item. Here the prawns head the list, the biggest haul being during August. After August there is a fall noticed till November, when later they are common till March, when again their numbers decrease till the end of July. The best months for *Penaeus* are August and the trimester March to May and not January and February as during the inshore fishing

experiments. The maximal seasons for the freshwater prawns are from August to October and again from December to March.

The crabs sold in the markets are usually *Scylla serrata*, the common estuarine crab, the Kalinandu (Kali = backwater) or Palaverkat nandu (so called because of its abundance in the Pulicat lake), the marine crabs *Neptunus pelagicus*, the Vari nandu, and *N. sanguinolentus*, the Munru Pulli (3 spots) nandu, and the fresh water crab *Telphusa leschenaultii*. According to the inshore fishing statistics of 1918–19 they were of no importance only 6 lb. having been caught that year. The best season for crabs as seen from the following table is the trimester March, April and May, though they are brought in good numbers to the markets in June, September and December:—

Months.	LB.	RS.	A.
July	15,888	2,626	8
August	26,426	4,047	8
September	36,365	3,547	6
October...	20,852	2,754	3
November	20,076	2,750	0
December	29,232	3,789	11
January	15,589	1,672	0
February	17,686	2,351	2
March	38,415	4,043	4
April	46,392	4,451	2
May	41,988	4,330	14
June	29,675	3,880	5
Total ...	338,584	40,243	15

The Silverbellies (Gerridæ) comprising the three genera *Equula*, *Gazza* and *Gerres* are the most important food fishes of the Madras waters taking the place of Valai (*Chirocentrus dorab*) in Tuticorin. According to the statistics of the inshore fishing experiments they occupy the fourth place, while in Tuticorin they were the eleventh in importance. These fish are greatly in demand by the poor who consume them as a delicacy, but are too small for European cookery. They are priced as cheap as 1 anna 9 pies per lb. and so are within the reach of the poor man's purse. The Tamil name of *Equula* and *Gazza* is Karal, but they are usually known as Karapodi to indicate their small size. The species included under this group are *Equula edentula* and *E. insidiatrix* (Suduppunam Karal), *E*

splendens (Kali Karal), *E. daura* (Namakaral), *E. blochii* and *Gazza minutah* (Kottu Karal), *Gerres lucidus* (Udan) and *Gerres filamentosus* (Val Udan).

As seen from the following statement August is the best month for Gerridae. *Equula* and *Gazza* are common from August till November, while the season for *Gerres* is from February to July.

Months.	Karapodi.			Udan.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	11,967	1,459	0	2,362	417	8	14,329	1,876	8
August	53,190	5,323	14	829	142	4	54,019	5,466	2
September ..	31,875	3,164	6	1,024	117	10	32,899	3,282	0
October ...	24,975	2,305	14	...	...		24,975	2,305	14
November ...	21,719	1,981	12	50	13	0	21,769	1,994	12
December ...	15,524	1,709	3	70	10	8	15,594	1,719	11
January ..	15,201	1,714	8	565	75	2	15,766	1,789	10
February ...	14,972	1,686	2	2,238	400	6	17,210	2,086	8
March ...	18,355	2,054	4	2,447	401	2	20,802	2,455	6
April	15,665	1,923	13	2,208	414	14	17,873	2,338	11
May	12,671	1,514	0	2,335	444	1	15,006	1,958	1
June	10,642	1,490	8	2,449	457	13	13,091	1,948	5
Total ...	246,756	26,327	4	16,577	2,894	4	263,333	29,221	8

The Ribbon fish or the hairtail (*Trichiurus*) forms the second most important food fish in Madras, while in Tuticorin it takes a very low place among the food fishes. During the inshore fishing experiments of Madras (1918–19) it did not figure as an important fish being seventeenth in rank. Three species of *Trichiurus* (Savalai, Olai valai and Karthigai valai) occur in Madras, *Trichiurus muticus*, *T. haumela*, and *T. savala*. These are sometimes used with deadly effect as bait for seer :—

Months.	LB.	RS.	A.
July	987	121	4
August	4,645	477	5
September	17,850	1,734	0

Months.				LB.	RS.	A.
October	...	...	...	114,051	10,370	2
November	...	...	...	51,329	5,085	3
December	...	...	...	23,576	3,094	3
January	...	...	...	23,053	2,612	4
February	...	...	...	9,432	886	12
March	...	...	...	3,045	353	4
April	...	...	...	3,670	379	5
May	...	...	...	5,322	558	3
June	...	...	...	3,947	467	4
		Total	...	260,907	26,139	1

From the above statement the best season for Savalai appears to be from September till January, the maximum catch being in October. November ranks next and as it is equivalent to the Tamil month Karthigai the Savalai is also known by the name of Karthigai Valai.

The horsemackerels, so named because of the supposed coarseness of their flesh, are the next in importance, though according to the Madras inshore fishing statistics are the 15th out of 39 food fishes. In Tuticorin they occupied the 14th place in the list of 36 food fishes. The species usually sold in Madras are *Caranx rottleri* (Komaraparai), *C. djedaba* (Morsing parai = Jew's harp horsemackerel), *C. affinis* (Semparai), *C. kalla*, *C. armatus* and *C. nigrescens* (Thengai parai or coconut fish), *C. ire* (Vennai parai or Butter-fish), *C. leptolepis* (Pulli parai or spotted horsemackerel), *C. speciosus* (Puli parai or tiger horsemackerel) and *C. hippos* (Manjal parai). They are all good eating and are included among primefish. This is the most important fishery in Madras as it fetches the highest total value among the fishes (crustaceans are excluded) of Madras.

Months.				LB.	RS.	A.
July	...	...	...	25,015	3,359	1
August	...	...	...	56,200	7,742	9
September	...	...	...	22,535	26,645	9
October	...	..	...	9,208	1,182	10
November	...	...	...	6,225	997	14
December	...	...	...	5,039	886	13
January	...	...	...	9,029	1,588	4

Months.	LB.	RS.	A.
February	9,595	1,537	12
March	25,620	3,734	5
April	23,566	3,331	13
May	23,927	3,871	1
June	22,696	3,916	3
Total ...	238,655	34,793	14

The season for horsemackerels as seen from the above statement is from March till September, the greatest catch being in August.

Lactarius delicatulus which is the 17th in importance out of the 36 food fishes of Tuticorin is an important fish in Madras. During the inshore fishing experiments, however, it was not much in evidence. It is considered very good eationg thugh Dr. Day says " it is insipid ".

Months.	LB.	RS	A.
July	5,778	832	5
August	23,484	2,814	8
September	13,137	1,443	1
October	26,140	3,032	4
November	12,409	1,594	10
December	7,251	1,064	12
January	11,801	1,856	13
February	15,281	2,677	13
March	20,122	3,215	13
April	12,058	1,868	4
May	12,224	1,978	5
June	15,540	2,094	8
Total ...	175,225	24,173	0

This fish occurs in good quantities for nearly ten months in the year ; the best month is October, August and March coming next.

The Jew fish which comes next in importance in Madras is an important food fish of Tuticorin being third in the latter list. In the Madras inshore fishery accounts it was the 16th out of the 39 fishes caught. The Jew fishes of Madras include three genera *Umbrina*,

Sciaena and *Otolithus*. The species seen were *Sciaena belangeri* and *S. albida* (Karungathalai), *S. albida* and *S. miles* (Vellai kathalai), *S. maculata* (Pulli kathalai), *S. maculata* and *Umbrina dussumieri* (Vari kathalai), and *S. aneus* and *Otolithus ruber* (Panna).

Months.	Kathalai.		Panna.		Total.	
	LB.	RS. A.	LB.	RS. A.	LB.	RS. A.
July	2,879	534 10	9,628	1,574 12	12,507	2,109 6
August ..	5,317	946 13	2,110	360 1	7,427	1,306 14
September ...	3,360	678 6	2,373	323 12	5,733	1,002 2
October ..	9,893	1,249 5	2,717	379 11	12,610	1,629 0
November ...	4,402	485 12	3,369	453 4	7,771	939 0
December ..	5,954	1,187 13	3,825	751 8	9,779	1,939 5
January ..	4,112	1,021 2	5,375	938 4	9,487	1,959 6
February ..	4,424	952 15	7,213	1,212 7	11,637	2,165 6
March	5,203	875 11	10,706	1,890 14	15,909	2,765 9
April	5,550	1,057 7	9,355	1,679 3	14,905	2,736 10
May	2,127	415 3	14,089	2,718 0	16,216	3,133 3
June	430	78 3	22,741	3,894 4	23,171	3,972 7
Total ...	53,651	9,483 4	93,501	16,176 0	147,152	25,659 4

From the above table the season for Jew fishes appears to be from February till July with the maximal period in June. They occur in good numbers also during October.

The Anchovies, the 5th important fish according to the inshore fishing experiment statistics, rank next in importance. They belong to the genus *Engraulis* the species found being *E. hamiltoni* and *E. malabaricus* (Poruwa), *E. indicus* and *E. tri* (Nethili). These are used as bait for large fish and it is this use in other countries that has secured for the fish the name whitebait in contradistinction to the other fish baits which are not silvery in colour. In May and June many *Engraulis tri* are found to carry near the tail region *Lernæid* parasites closely allied to *Cardiodectes*, and people are afraid to eat them then.

Months.	Nethili.			Poruwa.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	8,423	1,102	12	542	125	13	8,965	1,228	9
August	19,219	2,405	0	1,770	214	0	20,989	2,619	0
September ...	2,400	252	0	360	36	0	2,760	288	0
October	1,605	188	14	424	40	14	2,029	229	12
November ...	2,406	221	12	55	6	10	2,461	228	6
December ...	5,738	638	9	280	38	10	6,018	677	3
January	28,832	3,249	13	165	28	12	28,997	3,278	9
February	28,916	2,784	12	2,062	348	11	24,978	3,133	7
March	23,345	2,604	4	1,140	225	2	24,485	2,830	6
April ...	7,600	940	2	1,398	291	10	8,998	1,231	12
May	6,089	792	12	3,153	597	11	9,242	1,390	7
June	5,324	584	12	1,314	256	8	6,638	841	4
Total ...	133,897	15,765	6	12,663	2,211	5	146,560	17,976	11

The best season for anchovies is the trimester January to March and also the month of August. May and June, the most productive months during the inshore fishing experiments, were only as good as April, July or December this year.

The sardines, the second important fish of Tuticorin, also form one of the most important here. They include three species of *Clupea* and two of *Dussumieria*, viz., *Clupea melanura* (Kavalai), *C. brachysoma* (Nonalai), *C. kanagurta* (Seedai), *Dussumieria acuta* (Madhakandai) and *D. hasseltii* (Punduvirinthan, so called because it tends to putrefy soon and is recognized when cooked only by the bones, the flesh becoming a jelly-like mass).

Months.	Kavalai.			Madhakandai.			Nonalai.			Punduvirinthan.			Seedai.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	7,301	939	8	3,022	484	3	724	135	12	...	...		30	5	10	11,077	1,565	1
August ...	12,865	1,776	10	2,425	455	0	...	...		...	...		2,274	280	8	17,564	2,512	2
September ...	12.940	1,313	8	640	97	2	17.700	1.772	0	...	...		6,060	650	0	37,340	3,832	10
October ...	4,709	484	3	1,065	116	2	160	19	4	...	...		5,770	598	8	11,704	1,218	1
November ...	130	16	0	1,656	175	10	...	...		170	21	4	145	17	0	2,101	229	14
December ...	235	30	15	285	40	0	...	...		...	..		298	23	4	818	94	3
January ...	2,379	366	4	1,574	212	8	740	126	0	...	...		2,015	230	4	6,708	935	0
February ...	4,636	666	10	716	108	7	2,793	495	15	...	..		820	127	8	8,965	1,398	8
March ...	8,804	1,153	0	253	36	0	620	95	0	..	...		...	...		9,677	1,284	0
April	5,335	654	2	1,264	196	4	2,850	533	5	...	...		2,140	256	4	11,589	1,639	15
May	6,222	811	0	160	23	14	2,322	453	0	..	...		2,755	323	8	11,459	1,611	6
June	8.883	1,082	10	388	51	10	698	130	14	...	..		...	...		9,969	1,265	2
Total ...	74,439	9,294	6	13,448	1,996	12	28,607	3,761	2	170	21	4	22,307	2,512	6	138,971	17,585	14

August and September are the best months of sardine fishery in Madras, the September catch being more than double that of August. Sardines occur all the year round, but good hauls are had

only from January till October. The vagaries in sardine migrations may be seen by comparing the inshore fishery statistics with ours. *Clupea kanagurta* was completely absent in June 1922, while June 1919 produced the maximum catch of the year. October 1922, the best month of the year, was one of the poor months in 1919. In March 1922 and 1919 *Clupea kanagurta* was absent from Madras. In August and September 1922 *Clupea melanura* was most abundant. In 1919 it was absent in August and the September catch was a poor one.

The Indian herrings are another group of important fishes, though during the inshore experiments they were caught in small numbers. The Tamil names are Kuthuva (*Pellona hœveniijuv*), Therakuthwa (*P. indica*), Poovali (*P. elongata*) and Vengan (*P. brachysoma* and *P. hœvenii*).

Months.	Kuthuva.			Poovali.			Thera-kuthva.			Vengan.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July .	88	11	0	..	...		..	...		4,975	839	8	5,063	850	8
August ..	1,075	131	4	...	...		.	...		8,828	1,263	2	9,903	1,394	6
September.	1,110	102	8	...	...		...	...		12,710	1,566	2	13,820	1,668	10
October ..	690	71	0	80	9	14	...	...		24,670	2,697	4	25,440	2,778	2
November.	6,090	634	4	29	6	12	...	..		4,965	537	6	11,084	1,178	6
December.	4,960	527	11	20	5	8	...	...		2,649	349	3	7,629	882	6
January	2,628	276	8	...	..		300	49	0	8,479	1,008	4	11,407	1,333	12
February...	2,673	286	4	15	3	0	80	14	0	9,768	1,435	5	12,536	1,738	9
March ..	865	100	0		...		...	..		4,780	704	14	5,645	804	14
April ..	555	80	0		..		.	..		3,795	653	5	4,350	733	5
May .	920	108	0	..	...					8,256	1,581	14	9,176	1,689	14
June ..	535	63	0		...			...		8,228	1,539	8	8,763	1,602	8
Total ..	22,189	2,391	7	144	25	2	380	63	0	102,103	14,175	11	124,816	16,655	4

The Indian herrings, though occurring in good numbers all the year round, are most prolific in October, the other best months being January and February in the north-east monsoon and September and November in the south-west.

The grey mullets which are found in the sea, backwaters and freshwater are of some importance in Madras though not in Tuticorin. Under this name are included Madavai (*Mugil oligolepis,*

M. speigleri, *M. oeur*, *M. troscheli* and *M. cunnesius*), Nalla thannir Madavai (*M. troscheli* and *M. dussumieri*) and Perandai (*M. cunnesius* juv). The marine mullets being surface feeders delight in following up the tide into backwaters and the harbour feeding on algae, etc. They are very wily and in the backwaters of Ennore and Pulicat very ingenious methods of fishing are employed to capture them. They are good eating when fresh but decomposition sets in soon.

Months.	Madavai.		Fresh water Madavai.		Perandai.		Total.	
	LB.	RS. A.	LB.	RS. A.	LB.	RS. A.	LB.	RS. A.
July	10,999	2,181 15	260	40 0			11,259	2,221 15
August ...	7,666	1,224 5	...	..	150	23 0	7,816	1,247 5
September ...	5,514	865 12	150	20 0		..	5,664	885 12
October ...	3,780	564 12	...	...	...	..	3,780	564 12
November ...	4,986	672 0	..	...	..	...	4,986	672 0
December ...	10,908	1,796 2	...	...	210	57 4	11,118	1,853 6
January ...	11,432	1,954 2	...		..	..	11,432	1,954 2
February ...	9,948	1,495 14	29	4 8	...	...	9,977	1.500 6
March	16,528	2,567 14	20	2 8	...	...	16,548	2,570 6
April	15,833	2,545 11	..	...	...	..	15,833	2,545 11
May	13,992	2,399 4	...	...	...	...	13,992	2,399 4
June	8,295	1,402 8	...	...	.	...	8,295	1,402 8
Total ..	1,19,881	19,670 3	459	67 0	360	80 4	120,700	19,817 7

Mullets are available in good quantities all the year round the trimester March to May being their best season. January, July and December are also very good months. The roe of mullets is sold both fresh and salted. In November an enumerator mentions 4 lb. of roe sold in the Paracherikadai market for Re. 1-7-0, the rate being slightly over 5 annas 9 pies per pound which is more than double the price of a pound of mullets.

Sharks, though their flesh is coarse, are important economically. Muhammadans do not eat them because they bear living offspring like man! but Hindus, etc., eat them, many species being specially

recommended as food after child birth, during illness or in convalescence. The liver oil is considered to be of high medicinal value. Many species are found in Madras, those commonly sold being *Carcharias laticaudus*, *C. acutus*, *Mustelus manazo* (Pal sura—the flesh is supposed to stimulate milk in suckling mothers). *Notidanus indicus* (Matta sura), *Chiloscyllium indicum* (Kurangan sura) and *Zygaena blochii* the Hammerhead (Komban sura).

Months.	LB.	RS.	A.
July	7,856	1,882	0
August	8,466	1,759	2
September	4,697	747	12
October	5,497	908	1
November	7,205	1,494	0
December	10,290	2,231	3
January	10,210	1,958	10
February	9,119	1,914	0
March	11,519	2,321	10
April	9,665	2,125	0
May	8,978	2,259	6
June	12,442	2,595	6
Total ...	105,944	22,196	2

The best month for sharks is June; December, January and March are the next most productive months.

The Garfishes are more important in Madras among the food fishes than in Tuticorin. Two genera, Belone and Hemirhamphus, are included under this popular name. The following species were noticed:—*Belone cancila* the fresh water gar fish (kola), *Belone strongylura* (Usi kola) and *Hemirhamphus limbatus* (Palkolachee). These fish whose bones are green though eaten by the poorer classes, are rejected by many because of an unpleasant odour. *Belone* is said by fishermen to be the herald and companion of the mackerel. *Hemirhamphus* has a habit of leaping over the nets while fishing goes on. Flying-fish which are called Paravai kola were not captured this year, as the Rayapuram fishermen who went on kola fishing came home disappointed. Though occurring all the year round, they are prolific from December to June. In August nearly ten times the average catch of the prolific months was brought to the markets.

Months.	Kola.			Kolachi.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	7,359	1,176	12	100	14	0	7,459	1,190	12
August	35,939	4,122	14	...	...		35,939	4,122	14
September	8,045	989	12	...	...		8,045	989	12
October	540	84	3	...	...		540	84	3
November	621	70	10	..	...		621	70	10
December	2,457	312	14	...	...		2,457	312	14
January	1,900	272	6	..	...		1,900	272	6
February	2,581	373	2	...	...		2,581	373	2
March	3,248	418	2	.	...		3,248	418	2
April	4,415	546	13	...	...		4,415	546	13
May	5,566	790	0	..	...		5,566	790	0
June	4,465	606	3	...	...		4,465	606	3
Total ...	77,136	9,763	11	100	14	0	77,236	9,777	11

The sea-perches which come next in importance comprise many genera. The following statement gives the monthly quantities and values of the various kinds of sea perches sold in Madras :—

Months.	Kadichai			Kalawan.			Kallan-dalai.			Kandal.			Keechan.			Kilichai.			Sangara.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July ...	...	...		...	...		...	.		187	43	8	...	...		530	80	12	679	176	3	1,396	300	7
August ...	125	16	0	20	6	14	...	...		414	79	5	...	...		5,970	551	8	1,061	258	5	7,590	912	0
September.	435	50	0	17	6	12	60	7	0	749	130	9	30	3	0	2,935	321	14	1,900	370	4	6,176	889	7
October ...	2	0	3	15	2	8	...	...		713	112	14	..	...		...	...		870	160	7	1,600	276	0
November.	...	...		115	31	0	..	...		500	78	3	...	...		...	...		88	15	1	703	124	4
December ...	...	...		10	2	0	10	2	4	146	33	3	...	...		...	..		53	7	11	219	45	2
January ...	110	24	0	80	24	0	...	...		16	4	4	...	...		670	102	8	435	86	6	1,311	241	2
February ...	...	...		565	142	8	437	83	14	56	10	14	..	...		156	20	12	465	93	5	1,679	351	15
March ...	...	...		30	15	0	1,006	161	0	192	43	14	...	...		1,526	203	11	1,357	273	0	4,111	697	3
April ...	...	...		518	80	14	335	62	13	39	11	11	...	...		5,870	735	13	348	62	12	7,110	1,003	15
May ...	..	..		34	5	0	499	95	8	218	45	3	...	...		36,824	5,330	12	402	75	6	37,977	5,551	13
June ...	...	...		..	...		...	..		70	15	0	..	...		5,097	825	4	79	16	4	5,246	856	8
Total ...	672	90	3	1,404	316	8	2,347	412	7	3,300	608	8	30	3	0	59,628	8,222	14	7,737	1,596	4	75,118	11,249	12

The sea-perches occur all the year round, the best months being March to June and August to September, May being the most productive of all. *Serranus lanceolatus* the common kalawan is a valuable sea fish attaining a good size. Its flesh has an agreeable flavour. It is found in good numbers in February and April. Being a bottom feeder, it along with other fish of a similar habit is expected to contribute largely to the success of steam-trawling when such a method is introduced into our waters. Sangara (*Lutianus unimaculatus* and *L. annularis*—also called Nethiprion) occurs in August and September during the south-west monsoon and also in March. Kilichai (*Caesio cuning* and *C. chrysozona*)

occurs from April to June and August to September. In May an unusually heavy catch of this fish occurred. Kandal (*Synagris tolu*) is abundant from August to November. Kadichai (*Pristipoma dussumieri*) occurs only in January, August and September. *Pristipoma maculatum* occurs during the north-east monsoon (February to May). Its Tamil name, Kallandalai, has reference to the stones in the head which Indian doctors hold to be of high medicinal value. *Pristipoma* is called the grunter because of a grunting noise it produces when disturbed. *Therapon jarbua* the keechan though a valuable larvicide, was of no economic importance during the year when only 30 lb. were sold.

The cat-fishes are another important group of fishes. They usually occur in shoals. Though not eaten by the richer classes and avoided by the Muhammadans as fish without scales they enter largely into the dietary of the poor. The species noticed are the Kadalkeletni (*Macrones gulio*), Akkelethi (*Plotosus arab*), Irunkelethi (*P. canius*), Nattu kelethi, (*Macrones vittatus*), Solai kelethi (*M. cavasius*, the fresh water cat-fish), Theli (*Clarius batrachus* and *Saccobranchus fossilis*, the freshwater cat-fishes) and Uppu Kali kelethi (*Arius falcarius*). When large male specimens of *Arius* are caught, it is usual to find eggs measuring nearly ½ an inch in diameter falling from the mouth where they had been retained for purposes of hatching. The name Theli or scorpion fish is given as a poisonous secretion is injected into the severe wounds inflicted with the pectoral spines. The first business of the fishermen, as soon as these fish are caught, is to break offor hack away the dreaded spines.

Months.	Kelethi.			F W. Kelethi.			Theli.			Total.		
	LB.	RS	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	4,933	754	11	953	184	2		...		5,886	038	13
August ...	7,604	790	11	356	67	0	...	...		7,960	857	11
September	3,084	375	12	460	51	8	...	...		3,541	427	4
October ...	2,449	305	1	90	7	8	..	...		2,539	312	9
November	2,236	299	4	...	...		16	5	0	2,252	304	4
December	3,430	603	0	297	37	4	25	4	0	3,752	644	4
January ..	5,102	867	15	720	90	12	..	..		5,822	958	11
February	3,912	611	5	265	27	0	..	...		4,177	638	5
March ...	8,177	1,090	2	265	33	8	..	...		8,442	1,123	10
April	10,049	1,415	7	40	6	8	...	...		10.089	1,421	15
May ..	8,931	1,431	3	90	11	8	...	...		9,021	1,442	11
June ...	9,639	1,576	12	...	...		...	...		9,639	1,576	12
Total ...	69,546	10,121	3	3,536	516	10	41	9	0	73,123	10,646	13

The season for cat-fishes is from March to June, the maximum being reached in April. In the south-west monsoon August is of considerable importance.

The weight and value of the catches of the mackerel (*Scomber microlepidotus*—Kanangelethi) sold in Madras markets are as under—

Months.	LB.	RS.	A.
July	7,285	1,229	3
August	2,065	242	0
September	7,594	1,001	5
October	8,747	1,124	2
November	1,499	167	3
December	1,956	176	8
January	4,409	579	2
February	10,550	1,610	13
March	2,583	310	12
April	5,644	853	13
May	8,908	1,457	6
June	5,479	846	6
Total ..	66,719	9,598	9

Mackerel were obtained all the year round though in March, August, November and December they were scarce. The maximum quantity was sold in February, when during the inshore experiments of 1919, they were also found in plenty.

The red mullet or goat-fish (Navarai), an excellent food fish, is sold all the year round. The species seen were *Upeneus indicus* and *Upeneoides sulphureus*. The season as is seen from the following statement is August to January with a very low figure for October; March and June also seem to be good months for the Goat-fish.

Months.	LB.	RS.	A.
July	1,191	205	11
August	9.375	1,355	9
September	5,361	697	1
October	2,992	454	7
November	5,513	794	13
December	7,437	1,230	6
January	6,810	1,054	4
February	3,824	560	1
March	5,274	756	9

Months.	LB.	RS.	A.
April	2,106	305	6
May	2,991	459	1
June	5,322	723	5
Total ...	58,196	8,596	9

The pomfrets which are prime fish and in great demand among Europeans and the richer Indian classes are sold all the year round, the best month being August. The species seen were *Stromateus sinensis* (Mohan vowal), *S. cinereus* (Vellai vowal) and *S. niger* (Karuppu vowal), the first being commoner than the others. All the pomfrets examined among those imported from Pulicat and Ennore were *S. sinensis.* The weight and value of the catches of pomfrets are seen from the following statement :—

Months.	LB.	RS.	A.
July	4,692	1,539	8
August	7,016	1,999	15
September	1,430	297	0
October	5,630	998	0
November	5,233	1,163	15
December	4,642	1,404	7
January	2,757	868	2
February	2,605	1,005	15
March	2,452	817	13
April	2,635	1.003	2
May	5,509	2,277	14
June	4,571	1,961	12
Total ...	49,072	15,337	7

The fish next in importance is another prime fish which is also highly valued by Europeans. This is the seer and the species seen were Mavulasi (*Cybium commersonii*), Vellra (*C. guttatum*) and Vanjiram (*C. interruptum* and *C. guttatum* juv.) The seer is sold all the year round, the best month being November. The next best season is from January to March.

Months.	LB.	RS.	A.
July	2,304	1,125	4
August	1,296	540	7
September	697	211	9

Months.	LB.	RS.	A.
October	2,423	658	14
November	7,361	1,777	14
December	2,889	929	12
January	5,623	1,739	14
February	6,773	2,107	7
March	5,200	1,418	6
April	3,008	1,404	5
May	3,660	1,207	13
June	1,073	538	15
Total ...	42,207	13,660	8

Shrimps (Sinnakuni—*Acetes* spp.) are most abundant in December, the next best months being January and April. In February, May, August and November they occur in less numbers and lesser still during the remaining months except June when they are completely absent.

Months.	LB.	RS.	A.
July	150	20	2
August	2,597	307	4
September	375	37	8
October	135	11	11
November	2,590	167	4
December	12,216	1,106	14
January	5,945	812	6
February	1,270	180	12
March	320	46	0
April	5,991	786	11
May	1,415	218	0
June	...	...	
Total ...	33,004	3,694	8

The Dorab (*Chirocentrus dorab*), the most important fish of Tuticorin, sinks here into insignificance. It occurs throughout the year, but the season is from November to January. The weights

and value of the Dorab sold during the year are given in the following statement:—

Months.	LB.	RS.	A.
July	1,753	355	9
August	2,443	339	13
September	436	42	14
October	302	89	1
November	3,926	480	6
December	5,476	701	11
January	5,208	790	9
February	2,523	397	15
March	2,216	319	7
April	2,914	414	1
May	2,085	245	10
June	1,582	298	8
Total ...	30,865	4,475	8

Known as Valai in Tamil it is also commonly called Mulluvalai from being full of bones!

The Indian whiting, an excellent food fish, often brought to the European table is *Sillago sihama* (Kelangan). It occurs all the year round. July and August in the south-west monsoon and March and April in the north-east are the chief seasons.

Months.	LB.	RS.	A.
July	3,843	712	13
August	3,289	720	6
September	675	116	8
October	1,095	200	5
November	2,714	362	8
December	2,675	371	9
January	2,447	298	10
February	1,864	227	8
March	3,717	432	2
April	3,695	472	9
May	2,948	395	13
June	1,755	295	14
Total ...	30,719	4,607	9

The Nair fish or Cock-up (*Lates calcarifer*) is a very highly esteemed food fish being free from small bones. The frightful appearance of the mouth which gapes after death has acquired for it the Tamil name Koduwa. The fish is very common in backwaters. In Pulicat lake Koduwa fishing is an interesting event looked forward to with pleasure by the fishermen every year. During the hot months fishermen of all kuppams around the lake join together and with special large meshed nets fish specimens running even to 4 feet in length. The weights and values of Koduwa sold in the Madras markets during the year are as under—

Months.	LB.	RS.	A.
July	1,057	393	12
August	1,271	315	11
September	352	81	4
October	562	98	0
November	269	73	4
December	953	191	2
January	2,930	479	2
February	2,539	566	11
March	3,867	900	2
April	2,978	788	10
May	2,630	939	4
June	2,103	797	14
Total ...	21,511	5,624	12

The Indian salmon or "Roeball" is a fish held in high esteem. It is often caught both in the sea and backwaters by anglers standing on the shore. The species seen in the markets were *Polynemus sextarius*, *P. tetradactylus* and *P. indicus* (Kala). Though sold all the year round, the best months are February, April and October. The weights and values of roeball, or bamīn as it is also called, sold this year are—

Months.	LB.	RS.	A.
July	538	86	6
August	1,767	318	8
September	735	116	9
October	3,792	526	3
November	1,420	312	8

Months.		LB.	RS.	A.
December	... ...	1,163	245	8
January	... ...	1,096	291	7
February	... ...	2,004	343	4
March	... ...	1,368	224	4
April	... ...	2,118	392	6
May	... ...	985	147	14
June	... ...	1,085	193	14
	Total ...	18,071	3,198	11

The carps are an important group of fresh-water fishes of great economic value to the poorer classes. They are tasty, but too small and too bony for Europeans. The carps seen in the Madras markets are Kendai (*Nuria danrica* and *Barbus dorsalis*), Pannikendai (*Barbus chrysopoma*) and Vishakendai (*B. stigma*). The flesh of the last is bitter, but is, however, eaten because of its supposed medicinal value.

Months.	Kendai.			Pannikendai.			Vishakendai.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July ...	450	59	8	180	17	6	16	1	8	646	78	6
August ...	2,764	486	11		.		...	...		2,764	486	11
September ...	302	47	12		...		...	..		302	47	12
October ...	143	24	11	...	...			...		143	24	11
November ...	11	3	4	...	...		..	...		11	3	4
December .	5,474	1,435	4	...	...		...	...		5,174	1,435	4
January ...	1,870	490	8	..	...		..	...		1,870	490	8
February ...	382	47	12	...	...		...	...		382	47	12
March ...	589	59	4	52	7	12	19	3	0	660	70	0
April ...	3,430	992	0	200	28	9	46	6	0	3,676	1,026	9
May ..	312	86	4	138	20	1	64	8	8	514	114	13
June ...	76	7	2	468	52	9	32	4	0	576	63	11
Total ...	15,803	3,740	0	1,038	126	5	177	23	0	17,018	3,889	5

December is the favourite month for carps. In April and August carps are brought in good quantities to the markets.

The Gobies which are eaten by the poorer classes comprise many species of *Gobius* and one of *Eleotris*, viz., *Gobius criniger* (Upputhanni Uluvai), *G. neilli* and *G. cristatus* (Uluvai) found in estuaries, *G. giuris* (Nalla thanni Uluvai) the freshwater Goby and *Eleotris fusca* (Kaluluvai). This last is said to be good eating though too small for European cookery. One other species of *Gobius* (*G. acutipinnis*) is often seen in the markets mixed up with

the other Gobies. These when netted in shoals by themselves are usually thrown away by the fishermen.

Months.	Uluvai.		Freshwater Uluvai.		Total.	
	LB.	RS. A.	LB.	RS. A.	LB.	RS. A.
July	2,866	396 4	40	2 0	2,906	398 4
August	3,935	473 0	29	3 6	3,964	478 6
September	200	26 0	...	..	200	26 0
October	490	62 1	.	.	490	62 1
November	92	13 10	.	...	92	13 10
December	170	37 8	...	...	170	37 8
January	288	57 10	..	..	288	57 10
February	138	26 8	..	..	138	26 8
March	376	60 14	...	...	376	60 14
April	303	57 1	...	..	303	57 1
May	82	14 2	...	...	82	14 2
June	124	23 14	...	..	124	23 14
Total ...	9,064	1,250 8	69	5 6	9,133	1,255 14

Though sold all through the year, the best months for gobies are July and August.

The Queen fish (*Chorinemus tala*) is found in the markets all the year round, its season lasting from May till July. It is called Tholparai in Tamil as the fish is sworn to as the common prime fish, the horsemackerel, by untrustworthy butlers, etc., who peel off the skin which comes off easily.

Rays (Thirukkai) were sold for eleven months in the year, October being the exception. The season is from December to February. The species noticed were the sting-rays *Trygon uarnak* (Sonaga thirukkai) and Trygon walga (Sembadaka thirukkai) and the Eagle ray *Aetobatis narinari* (Kurivi thirukkai). The tail which is like a whiplash carries powerful spines with which frightful wounds can be inflicted and which the fishermen chop off with vindictive animosity, at times even with the tail. The rays are all highly esteemed by the masses.

Barracuda (*Sphyraena jello* and *S. commersonii*) the Ula, is said to be good eating though some believe the ripe females and the roe to be poisonous. This perhaps accounts for the absence of these fish from the markets during the cold months when they breed. They are available for sale from January to August, the best month being July.

Soles are prime fish. *Psettodes erumei* (Erumai nakku), the largest flat fish of Madras, and *Pseudorhombus arsius* (Nakku) are common and valuable food fishes. Other soles seen in the markets are *Cynoglossus lingua* (Vari Allu), *Plagusia marmorata* (Nedu Nakku), *Synaptura cornuta* (Vari Allu) and *S. commersoniana* (Nakku). Synaptura is not esteemed as food in Madras. Soles were sold all the year round, the best months being August and September.

Ophiocephalus, the Murrel, is a valuable freshwater food fish. Three species are sold here, *O. striatus* and *O. punctatus* (Viral) and *O. gachua* (Koravai).

Months.	Koravai.			Viral.			Total.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
July	...	.		168	41	8	168	41	8
August	222	39	10	530	102	9	752	142	3
September	403	53	8	266	56	1	669	109	9
October	187	24	14	89	22	9	276	47	7
November	140	16	5	127	27	12	267	44	1
December	60	14	12	61	20	8	121	35	4
January	35	8	6	244	62	15	279	71	5
February	...	...		30	8	8	30	8	8
March	...	..		72	16	12	72	16	12
April	18	4	0	250	56	0	268	60	0
May	...	...		643	123	0	643	123	0
June	...	...		330	64	12	330	64	12
Total ...	1,065	161	7	2,810	602	14	3,875	764	5

Murrel is available throughout the year, but the best months are May, August and September.

The two species of Seabreams, *Chrysophrys sarba* (Vellai Mattivan) and *C. datnia* (Karuppu mattivan) are excellent eating, but should be cooked soon after being caught as decomposition sets in very early. The season is from February to April but, till July they continue to be caught in less quantities. During the other months except November odd quantities are brought to the markets.

The two species of Sand eels or Spined eels *Mastacembelus armatus* and *Rhyncobdella aculeata* (Aral) occasionally seen in Madras markets are much esteemed as food. These fish, sometimes miscalled lampreys, were sold in good number in August, the next best month being March. They were absent in February, May to July and October. Their Tamil name, Chethu aral, indicates their habitat, the muddy bottom of fresh-water ponds.

The Butterfish (*Elacate nigra*—Kadalviral), a nice edible fish, was available though not in good numbers from January to August, the best month being June.

Valai or Eri Valai, the fresh-water shark (*Wallago attu*), an esteemed fresh-water food fish the rejection of which is, however, advised by Indian doctors who believe it to cause rheumatism, is sold in the markets from June till January, the best months being August and September.

Surai or Ratha Surai (as the flesh is purplish) the Bonito (*Thynnus pelamys*) was sold from February till July and also in November. This fish is said to accompany shoals of sardines and flying fish. This statement is partly verified by the fact that sardines were found in good numbers during the Bonito season. But during the maximal season of sardines August to October not a single Bonito was seen in the markets.

The lizard-fish (Thumbili– *Saurida tumbil*) was seen in the markets in January and February during the north-east monsoon and in August and September during the south-west.

Megalops cyprinoides (Morankendai) was sold from August to September, small quantities being available in October and January.

The squids (*Loligo* spp) and the cuttle-fish (*Sepia* spp.) were sold from August to October. In June only 10 lb. were sold. These Kadamban with the Devil-fish, Pey Kadamban (*Octopus* sp.), are used as bait.

The Spade-fish (Thirattai—*Drepane punctata*) is good eating like pomfret. It is sold in August and November, lesser quantities being available in September, December, January and February. When steam trawling is done, large quantities of this bottom-haunter are expected to be caught.

Oramin (*Teuthis java* and *T. concatenata*) is sold in August and September. Smaller quantities are sold in October and January.

The Bat-fish (Sadakkan—*Platax vespertilio*) was sold in September.

The sandbugs (*Hippa asiatica*) are crustaceans known as Illipuchi found buried in the sand within the surf zone. Besides their use as bait, they are valued by the poor classes who pound them into a curry. 125 lb. were sold in December and 20 in February.

Eels (Vilangu) are abominated by Hindus who regard them as serpents (cf. the Scots belief that eels are descendants of Eve's temptress) and are rejected by Muhammadans because of their scaleless nature. The ones caught are usually those that have got into the net accidentally. They are, however, such good eating that the odour of cooking eels is said to make a dead man sniff. The fish fetch a high price (5 as. 6 ps. per lb.) and are recommended by Indian doctors as diet for invalids. The liver is said to be an antidote to poisons. *Muraena macrura* and *Anguilla bengalensis* were the two species seen in the markets where they were sold in July, August and December.

Padangan (*Rhinobatus thouini*), the plough fish, was brought to the markets in November.

The Crocodile-fish (Udupathy—*Platycephalus insidiator*) though often rejected by fishermen is eaten by the poorer classes who sometimes buy them as in July of this year.

Kozhimin (*Acanthurus matoides*), the surgeon, was sold in the markets in January and April. It is the most highly priced (7 annas 6 pies per lb.) fish in Madras.

Allathy (*Elops saurus*), the Gally-wasp, was sold in January.

Pulli pilachai (*Tetrodon patoca*), the puffer, is an inedible fish of no economic value. It is rejected by fishermen as eating its indigestible flesh is said to bring on vomiting and purging with sometimes fatal effects. The flesh, however, is said to be tasty and is recommended by Indian doctors as food for consumptives. The pleasant taste and the disastrous effects of eating it are set forth in a Japanese proverb which says "Great is the temptation to eat

'Fugo' (puffer), but greater is the dread of losing life." This year 30 lb. of puffers were sold for Rs. 2 in the Egmore market on 20th December 1921 apparently for medicinal use.

Thalari (*Opisthopterus tartoor*) was seen in the markets in October.

Ten lb. of Pachakutty (*Chatoessus nasus*) were sold in December. This fish which usually occurs in large shoals is good eating though bony.

Vangaravasi (*Harpodon nehereus*), the Bombay Duck, is a rare fish, 10 lb. having been available in March. The fish which is coated with plenty of mucus is very good eating and is reckoned a delicacy when fried in ghee.

Ullam (*Clupea ilisha*), the Sable fish or Hilsa, is such a highly esteemed food fish that a Tamil proverb advises one to sell all that he has to buy it. In Sanskrit it is Matsya Raja, the king of fishes. A rich food before the eggs are deposited, the fish has so many bones that one has to be careful in eating it. Only 2 lb. of this fish were sold in the Madras markets during the statistical year and that was in October. The following statement gives the monthly statistics of the different kinds of fish sold in Madras during the year 1921–22:—

Names.	July.			August.			September.			October.			November.			December.		
	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
Prawns	35,524	5,359	9	88,539	14,624	5	74,981	9,489	8	55,361	6,697	15	40,734	4,605	1	67,236	8,342	9
Crabs	15,888	2,626	8	26,426	4,047	8	36,365	3,547	6	20,852	2,754	3	20,076	2,750	0	29,232	3,789	11
Silverbellies ...	14,329	1,876	8	54,019	5,466	2	32,899	3,282	0	24,975	2,305	14	21,769	1,994	12	15,594	1,719	11
Ribbon fish ...	987	121	4	4,645	477	5	17,850	1,734	0	114,051	10,370	2	51,329	5,085	3	23,576	3,094	3
Horsemackerel.	25,015	3,359	1	56,200	7,742	9	22,535	2,645	9	9,208	1,182	10	6,225	997	14	5,039	886	13
(Lactarius) ...	5,778	832	5	23,484	2,814	8	13,137	1,443	1	26,140	3,032	4	12,409	1,594	10	7,251	1,064	12
Jew fishes ...	12,507	2,109	6	7,427	1,306	14	5,733	1,002	2	12,610	1,629	0	7,771	939	0	9,779	1,939	5
Anchovies ...	8,965	1,228	9	20,989	2,619	0	2,760	288	0	2,029	229	12	2,461	228	6	6,018	077	3
Sardines ...	11,077	1,565	1	17,564	2,512	2	37,340	3,832	10	11,704	1,218	1	2,101	229	14	818	94	3
Indian herrings.	5,063	850	8	9,903	1,394	6	13,820	1,668	10	25,440	2,778	2	11,084	1,178	6	7,629	882	6
Grey mullets ...	11,259	2,221	15	7,816	1,247	5	5,664	885	12	3,780	564	12	4,986	672	0	11,118	1,853	6
Sharks ...	7,856	1,882	0	8,466	1,759	2	4,697	747	12	5,497	908	1	7,205	1,494	0	10,290	2,231	3
Garfish .	7,459	1,190	12	35,939	4,122	14	8,045	989	12	540	84	3	621	70	10	2,457	312	14
Sea-perches ...	1,396	300	7	7,590	912	0	6,176	889	7	1,600	276	0	703	124	4	219	45	2
Cat-fishes ...	5,886	938	13	7,960	857	11	3,544	427	4	2,539	312	9	2,252	304	4	3,752	644	4
Mackerel ..	7,285	1,229	3	2,065	242	0	7,594	1,001	5	8,747	1,124	2	1,499	167	3	1,956	176	8
Red mullet ...	1,191	205	11	9,375	1,355	9	5,361	697	1	2,992	454	7	5,513	794	13	7,437	1,230	6
Pomfrets ..	4,692	1,539	8	7,016	1,999	15	1,430	297	0	5,630	998	0	5,133	1,163	15	4,642	1,404	7
Seer	2,304	1,125	4	1,296	540	7	697	211	9	2,423	658	14	7,261	1,777	14	2,889	929	12
Shrimp ...	150	20	2	2,597	307	4	375	37	8	135	11	11	2,590	167	4	12,216	1,106	14
Dorab	1,753	355	9	2,443	339	13	436	42	14	302	89	1	3,926	480	6	5,476	701	11
Whiting ..	3,843	712	13	3,289	720	6	675	116	8	1,096	200	5	2,714	362	8	2,675	371	9
Cock-up ...	1,057	393	12	1,271	315	11	352	81	4	562	68	0	269	73	4	953	191	2
Indian salmon.	538	86	6	1,767	318	8	735	116	9	3,792	526	3	1,420	312	8	1,163	245	8
Carps	646	78	6	2,764	486	11	302	47	12	143	24	11	11	3	4	5,474	1,435	4
Goby	2,906	398	4	3,964	478	6	200	26	0	490	62	1	92	13	10	170	37	8
Queen fish ..	1,275	246	8	84	11	4	130	10	10	213	26	4	188	48	7	396	107	0
Rays	369	151	2	266	72	3	152	34	0	...	...		908	140	10	1,268	255	2
Barracuda ...	1,758	381	15	671	179	8	...	..		..	...		...	...		...	..	
Sole	12	2	4	2,164	256	11	1,280	204	14	325	35	0	659	119	14	410	66	11
Murrel	168	41	8	752	142	3	669	109	9	276	47	7	267	44	1	121	35	4
Seabream ...	166	38	0	50	13	4	22	2	7	2	0	7	...	...		32	8	8
Sand eel ...	...	...		1,206	294	12	75	10	0	...	...		10	3	0	112	33	8

Butter-fish ...	180	55 10	7	2 0	...	...	...	...		...	...	...
Fresh-water shark ...	20	7 8	313	41 4	320	31 12	195	20 8	105	10 10	138	21 0
Bonito .	168	41 4	...	..	..		...	..	95	19 0	...	...
Lizard fish ...	...	...	369	100 0	70	17 8	...	..	...	...	...	...
(Megalops) ..	...	...	147	18 8	285	27 15	7	1 0	...	...	...	..
Squids, etc. ...	...	...	199	31 0	65	8 0	164	20 12	...	.	...	...
Spade fish ..	...	...	202	39 0	6	1 6	..		100	11 4	10	2 0
(Teuthis) ...	.	.	154	20 10	206	25 6	2	0 6	..	...	..	..
Bat-fish	...	...	..	..	250	20 0	.	...	..	...		
Sandbugs ...	...	...	...	...	...		...	..	...	.	125	12 8
Eels	77	23 9	30	9 2	..	..	...	..			12	0 12
Plough-fish ..	...		..	...	...	...	...		75	6 0	...	...
Crocodile-fish ...	45	10 6	...	...	...		...	..	...	.	...	..
Sargeon ...	...	...	...	...	...	...	...			...	...	...
Gallywasp	..	...	...	...	...	...	...	...		.	..	...
Puffer	...	...	...	...	...	...	...	.	...	...	30	2 0
(Opisthopterus).	...	...	..	...			25	3 6	...	...	...	
Chatoessus ...	...	...	...	...	...	.	...			...	10	2 0
Bombay duck	...	..	...	..	..	..		...	...	...	..	...
Hilsa			..		..	...	2	0 0			..	.
Miscellaneous ...	24,473	3,760 13	76,234	8,673 8	94,990	9,871 6	91,717	9,335 5	46,528	4,962 2	58,222	8,529 10
Total ...	224,065	37,367 15	497,662	68,913 2	402,223	45,123 0	435,566	48,082 8	271,089	32,949 13	3,05,945	44,484 1

Names.	January.			February.			March.			April.			May.			June.			Total.		
	LB.	RS.	A.	LB	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.	LB.	RS.	A.
Prawns	52,958	7,273	4	50,814	7,526	5	64,510	7,891	15	54,164	6,603	9	52,617	6,618	2	41,216	6,086	5	678,654	91,118	7
Crabs	15,589	1,672	0	17,686	2,351	2	38,415	4,043	4	46,392	4,451	2	41,988	4,330	14	29,675	3,880	5	338,584	40,243	15
Silverbellies ...	15,766	1,789	10	17,210	2,086	8	20,802	2,455	6	17,873	2,338	11	15,006	1,958	1	13,091	1,948	5	263,333	29,221	8
Ribbon fish ...	23,053	2,612	4	9,432	886	12	3,045	353	4	3,670	379	5	5,322	558	3	3,947	467	4	260,907	26,139	1
Horsemackerel.	9,029	1,588	4	9,595	1,537	12	25,620	3,734	5	23,566	3,331	13	23,927	3,871	1	22,696	3,916	3	238,655	34,793	14
(Lactarius) ...	11,801	1,856	13	15,281	2,677	13	20,122	3,215	13	12,058	1,868	4	12,224	1,978	5	15,540	2,094	8	175,225	24,473	0
Jew fishes ..	9,487	1,959	6	11,637	2,165	6	15,909	2,766	9	14,905	2,736	10	16,216	3,133	3	23,171	3,972	7	147,152	25,659	4
Anchovies ..	28,997	3,278	9	24,978	3,133	7	24,485	2,830	6	8,998	1,231	12	9,242	1,390	7	6,638	841	4	146,560	17,976	11
Sardines ..	6,708	935	0	8,965	1,398	8	9,677	1,284	0	11,589	1,639	15	11,459	1,611	6	9,969	1,265	2	138,971	17,585	14
Indian herrings.	11,407	1,333	12	12,536	1,738	9	5,645	804	14	4,350	733	5	9,176	1,689	14	8,763	1,602	8	124,816	16,655	4
Grey mullets ...	11,432	1,954	2	9,977	1,500	6	16,548	2,570	6	15,833	2,545	11	13,994	2,399	4	8,295	1,402	8	120,700	19,817	7
Sharks	10,210	1,958	10	9,119	1,914	0	11,519	2,321	10	9,665	2,125	0	8,978	2,259	6	12,442	2,595	6	105,944	22,196	2
Gar-fish ...	1,900	272	6	2,581	373	2	3,248	418	2	4,415	546	13	5,566	790	0	4,465	606	3	77,236	9,777	11
Sea-perches .	1,311	241	2	1,679	351	15	4,111	697	3	7,110	1,003	15	37,977	5,551	13	5,246	856	8	75,118	11,249	12
Cat-fishes ...	5,822	958	11	4,177	638	5	8,442	1,123	10	10,089	1,421	15	9,021	1,442	11	9,639	1,576	12	73,123	10,646	13
Mackerel ...	4,409	579	2	10,550	1,610	13	2,583	310	12	5,644	853	13	8,908	1,457	6	5,479	846	6	66,719	9,598	9
Red mullet ...	6,810	1,054	4	3,824	560	1	5,274	756	9	2,106	305	6	2,991	459	1	5,322	723	5	58,196	8,596	9
Pomfrets ...	2,757	858	2	2,605	1,005	15	2,452	817	13	2,635	1,003	2	5,509	2,277	14	4,571	1,961	12	49,072	15,337	7
Seer	5,623	1,739	14	6,773	2,107	7	5,200	1,418	6	3,008	1,404	5	3,660	1,207	13	1,073	538	15	42,207	13,660	8
Shrimps ...	5,945	812	6	1,270	180	12	320	46	0	5,991	786	11	1,415	218	0	..	...		33,004	3,694	8
Dorab	5,208	790	9	2,523	397	15	2,216	319	7	2,914	414	1	2,086	245	10	1,582	298	8	30,865	4,475	8
Whiting ...	2,447	298	10	1,864	227	8	3,717	432	2	3,696	472	9	2,948	395	13	1,755	296	14	30,719	4,607	9
Cock-up ...	2,930	479	2	2,539	566	11	3,867	900	2	2,978	788	10	2,630	939	4	2 103	797	14	21,511	5,624	12
Indian salmon.	1,096	291	7	2,004	343	4	1,368	224	4	2,118	392	6	985	147	14	1,085	193	14	18,071	3,198	11
Carps	1,870	490	8	382	47	12	660	70	0	3,676	1,026	9	514	114	13	576	63	11	17,018	3,889	5
Goby ...	288	57	10	138	26	8	376	60	14	303	57	1	82	14	2	124	23	14	9,133	1,255	14
Queen fish ..	515	145	12	566	184	8	961	227	14	441	158	12	1,133	434	0	2,608	503	8	8,510	2,104	7
Rays	1,955	432	9	1,223	229	12	137	19	0	314	85	0	479	112	0	687	169	14	7,758	1,701	4
Barracuda ...	252	57	12	758	141	15	344	55	6	787	129	0	740	121	7	904	142	8	6,220	1,209	7
Sole	538	107	4	226	39	0	393	54	2	56	8	0	65	9	8	60	11	4	6,188	915	1
Murrel	279	71	5	30	8	8	72	16	12	268	60	0	643	123	0	330	64	12	3,875	764	5
Sea bream ...	26	5	14	644	107	10	506	82	12	332	58	1	100	18	12	254	47	10	2,134	383	5
Sand eel ..	16	8	0	...	...		205	29	0	68	11	0	...	...		...	...		1,692	389	4

Butter-fish ...	136	39	2	27	6	0	209	66	0	210	62	6	197	77	8	324	113	12	1,290	422	6
Fresh-water shark.	60	16	0	...	...		...	...		...	...		...	...		132	36	2	1,283	184	12
Bonito ...	...	...		191	40	12	233	56	12	173	42	11	218	62	1	176	47	12	1,254	310	4
Lizard-fish ...	20	4	4	10	2	0	...	...		...	...		...	...		..	...		469	123	12
(Megalops) ...	10	1	4	...	...		...	...		...	...		...	...		...	...		449	48	11
Squids, etc. ...	10	2	8	..	...			...		...	...		...	...		...	...		438	62	4
Spade fish ..	15	3	8	80	14	0	...	...		...	...		...	...		...	...		413	71	2
(Teuthis) ...	15	2	7	...	...		...	...		...	...		...	...		...	...		377	48	13
Bat-fish ...	...	...		...	...		...	...			.		...	.		...	...		250	20	0
Sandbugs ...	...	...		20	1	4	...	...		...	...		...	...		...	...		145	13	12
Eels		...		...	...		...	...		...	...		...	...		...	...		119	33	7
Plough-fish ..	..	..		...	...		...	..		.	...		...	...		...	...		75	6	0
Crocodile.fish .	...	...		...			...	...		...	...		...	...		...	...		45	10	6
Surgeon ...	16	12	0		...		..	...		28	8	12	...	...		...	...		44	20	12
Gallywasp ...	40	6	12	...			...	...		...	...		...	...		...	...		40	6	12
Puffer	...	...		...	...		..	...		...	...		...	...		...	...		30	2	0
(Opisthopterus).	...	...		..	...		...	...		...	..		...	...		...	...		25	3	6
(Chatoessus) ..	...	...		...	...		...	...		...	...		...			.	.		10	2	0
Bombay duck ..	...	...		...	...		10	2	8	...	...		...	...		..	...		10	2	8
Hilsa	...			...	...		...	...		...	.		...			..	...		2	0	9
Miscellaneous .	52,212	7,648	15	44,306	7,127	5	52,586	7,462	0	58,180	8,220	0	44,215	6,259	3	26,599	4,262	4	670,262	86,112	7
Total ...	310,968	45,710	11	288,220	45,257	2	355,787	49,939	2	340,603	49,305	15	352,235	54,277	11	270,537	44,255	15	4,054,900	5,66,466	15

The population of Madras City according to the latest census is 526,911, of whom Hindus number 427,722, Muhammadans 53,163, Christians 44,136 and Jains 1,057. The fish-eating population consists of Muhammadans, Christians and a majority of Hindus. The Jains touch no sort of animal food and among the Hindus the Brahmans who form about 6 per cent and the orthodox Saivites generally do not eat flesh, or fish. Taking into consideration the many days when fish food is tabooed to Hindus, the minimum proportion of fish-eating Hindus may be fixed at 50 per cent. Thus the total number of fish-eaters in Madras, who would eat fish if it can be procured, is about 300,000. The total quantity of fish consumed in Madras during the statistical year is 4,054,900 lb. Thus if all who would eat fish in Madras were supplied with fish, the quantity allotted per head would be 13½ lb. in one year!

This means that the supply is insufficient. Nearly fifty years ago when an enquiry into fish supply and demand was conducted in the Tinnevelly and Madura districts, the result was the same, that demand exceeded the supply and a correspondent to the *Madras Mail* said in August 1873 that fish-eaters there, finding the supply of fish insufficient, supplemented it by indenting on frogs, four edible species of which are common in the Madras Presidency! Thanks to the activities of the Madras Fisheries Department, trawling experiments and the inshore fishing experiments have revealed the existence of untapped sources of fish supply which can be harvested when better financial conditions prevail. Important problems of life histories, etc., of fishes are being tackled, to enable the Department to devise well-founded schemes for increasing the fish supplies.